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UTILIZATION OF HARDWOODS IN NORTHERN ALBERTA

SUMMARY REPORT

prepared for:

Alberta

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Prepared for: Northern Alberta Development Council

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A Division of H.A. Simons (International) Ltd.
Vancouver, B.C.

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SUMMARY REPORT

Introduction

This is the summary report of Utilization of Hardwoods in Northern Alberta.* The Northern Alberta Development Council (NADC) commissioned an examination of the current status and development prospects for the northern hardwood resource. The NADC, together with assistance from Alberta Economic Development and Alberta Energy and Natural Resources, established a joint government-industry study steering committee, and employed Woodbridge, Reed and Associates Ltd.to complete the research project.

For many years, northern Alberta's extensive hardwood resources have been recognized as having considerable potential for development. Current harvest levels are higher than a few decades ago, and some notable successes have been achieved in forest products manufacturing investment based on the resource. Nevertheless, there are extensive tracts of hardwoods throughout Alberta which are significantly underutilized. The hardwood resource in northern Alberta comprises three species which grow to commercial size. Trembling aspen is the most numerous of the three and accounts for 81 per cent of the total standing hardwood inventory. Balsam poplar and white birch account for a further 15 per cent and 4 per cent respectively.

The reader should bear in mind that the factors determining the rate of timber utilization, in the forest products industry, are 1) markets and 2) economics. There is a well documented evolution in utilization worldwide whereby, for sound commercial reasons, preferred species and sizes normally are harvested first. Later, as the supply of these declines and the costs of logging less accessible sites increases, the commercial value of other species is enhanced and higher levels of utilization commence. An exception to this is where technological or market changes shift the balance of desirability in favour of lesser utilized species. This has been the case, for example, with aspen waferboard and oriented strand board (OSB) which are now produced in Alberta and in other areas.

It appears that there are grounds for cautious optimism that much more of northern Alberta's hardwood resources could become economically attractive for forest product investment within the next five to ten years. A number of recent studies have pointed to this possibility.

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* For more detailed information, the reader is directed to the main report.

Alberta's Fibre Reserves in the Global Context

In the past decade, there has been a great deal of discussion about the prospect of global deficits in economically accessible supplies of softwood and hardwood timber. This has caused concern in some major traditional supplying areas, such as Canada, where it was assumed that the softwood timber reserve was much greater. The other side of the picture, however, has been an increased level of interest in "fibre supply" potential from (a) "new" supplying areas (particularly in plantation developments, e.g. Brazil, South Africa, Chile, etc.) and (b) areas of timber previously considered to be marginal by virtue of location, stand-densities, species, timber quality and so on.

In the late 1970's, Alberta certainly justified a position on most timber companies' "shopping-lists" as an area for expansion. Significantly Alberta's estimated 17 million cubic metre reserve represents the largest incremental wood supply in all of Canada. Given the recent recession, however, the immediate outlook for many companies is for priorities to be placed on upgrading of existing facilities in currently committed areas.

The analysis presented in this study indicates that Alberta still can offer competitive strengths in a number of important aspects. The reality is that the comparative attractiveness of these factors has to be viewed in the context of a much more competitive climate for new investment. Development of these resources is not so much a question of "if" as "when".

Current Utilization of Hardwoods in Alberta

There is, as of 1984, one waferboard plant and one OSB (Oriented Strand Board) plant in Alberta using aspen as their raw material. The waferboard plant is located at Slave lake. In 1979 the plant was purchased by Weldwood and extensive modernization was carried out. The plant commenced full operation in 1981 and has been producing waferboard since that time with a few temporary closures due to poor market conditions.

The OSB plant at Edson is of much more recent origin. It commenced full operation in 1984 and is a very modern plant with state-of-the-art technology producing a high quality product.

Apart from these two major facilities, hardwood logs are also utilized by a number of small sawmills. In total there are about 25 mills on record as cutting aspen. However, a number of these are very small and only operate on a sporadic basis producing less than one million board feet annually. Their products tend to be utilized very locally for construction purposes or are sold for a variety of low value uses such as pipe racks, dunnage and pallets.

Hardwood utilization for pulp in Alberta currently is limited to experimental volumes for aspen bleached kraft market pulp (BKP) at Procter & Gamble's Grande Prairie softwood bleached kraft market pulp. A specialty pulp/paper mill utilizing aspen has been proposed by Makin for the Drayton Valley area.

The Hardwood Species in Northern Alberta

Three species of hardwood grow to commercial size in northern Alberta: trembling aspen, balsam poplar and white birch. Trembling aspen is the most numerous of the three in Alberta. In fact, it is the most widely distributed tree species in North America. A major constraint to utilization in northern Alberta is that essentially the same type of resource occurs in many locations closer to some major North American population centres.

The extensive occurrence of aspen is in large part a result of its successful ability to regenerate through root suckering. This allows reestablishment after fire, logging, insects or disease have caused death of the overstory, as long as the root system has not been killed. It is also well adapted to extensive forest management, where the forester wishes to re-establish growth and stocking as quickly and inexpensively as possible after clear-cutting.

Balsam poplar, like aspen, is an early successional species with striking capabilities to reproduce naturally through root suckers or stump sprouts after disturbance. While the species is common, it is much less abundant than aspen. It is often found intimately mixed with aspen, a situation which is problematic for existing panelboard operations in Alberta which currently utilize only aspen. White birch is the least abundant of the three hardwood species.

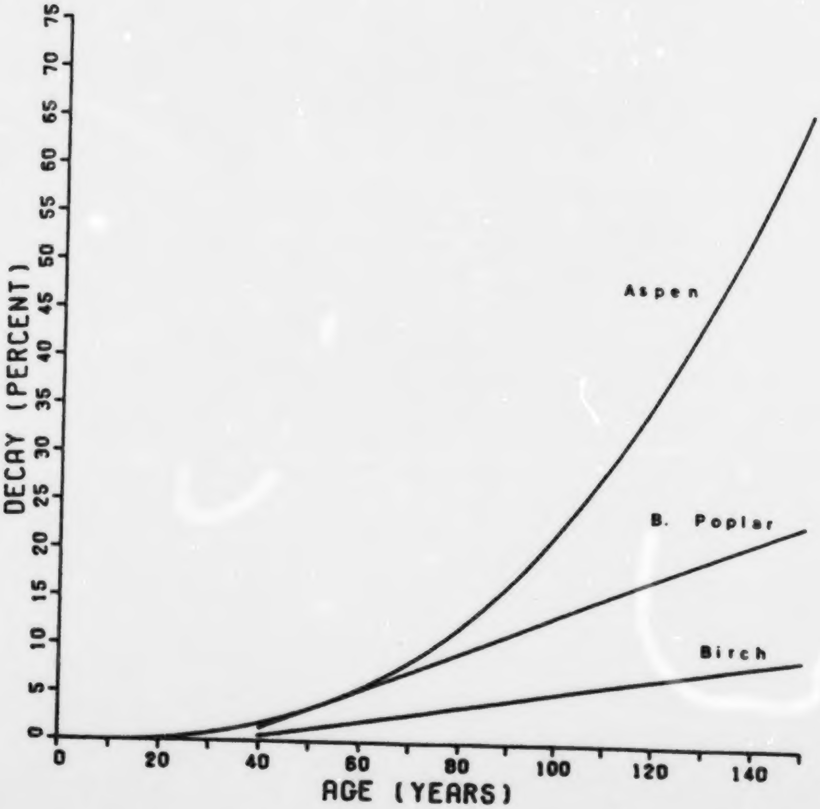
Defect in the Hardwood Resource

Trembling aspen and balsam poplar are subject to a number of decay diseases which cause timber loss and degradation of wood quality. Decay is of paramount importance in any consideration of hardwood utilization in northern Alberta. The most frequently reported decay organism in northern Alberta is **Fomes igniarius**, often referred to as white heart rot or white trunk rot. It is more prevalent in aspen than in balsam poplar. The rot enters the trunk of the tree through wounds such as where branches have broken off or where frost cracks have opened the bark. Infection goes through several stages including stain (where the wood is discoloured but the structural integrity is maintained), through incipient or intermediate decay (when the cell walls making up the wood are beginning to break down), to advanced decay (when the wood is soft and visibly decomposed).

Although the significance of decay to commercial development of the resource is accepted, our ability to predict the extent of decay in existing or future hardwood stands is poor. In this study, we attempted to relate the percentage of decayed wood to stand age. Relating decay to other site variables was considered futile at this time, either because research had failed to quantify the relationship or because Alberta inventory data did not include the potential indicator variables.

In order to construct a simple mathematical model which could be used to predict decay levels from forest inventory projections, various formulae were manipulated until curves were obtained which seemed to best represent the relationship between decay and age. Given the amount of variation observed in the literature and in production experience, the selection of such curves was necessarily subjective and the resulting predictions will obviously deviate widely from the actual cull percentages encountered in many specific situations. Figure 1 summarizes these predictions. Note the exponential increase in decay forecast for aspen. The stand is considered effectively "broken-up" and unusable by 140 years of age, when the decay percentage exceeds 50 per cent.

Figure 1
(Extracted from Section 2.0)
Percentage of Decayed Volume Predicted in Relation to Age for
Aspen, Balsam Poplar and Birch



A central implication then, on the resource side of the utilization question, is that decay is unpredictably distributed throughout the tree in such a way that, although only 10 to 20 per cent of the wood might be rotten, loggers and manufacturers experience great difficulty in economically recovering the sound wood.

This means that many of the aspen trees in northern Alberta are either already too old and decayed to be utilized or are presently too small. Timing is critical in the successful utilization of the species and the logistic difficulties of harvesting the trees when they are large enough for manufacture, but before they succumb to decay, are not easily overcome.

The Phase III Inventory

The Alberta Forest Service has just completed a major assessment of the province's timber resources. This has provided the best, publicly available, assessment so far of Alberta's hardwoods. For the purposes of this study, analysis of these new data has been carried out in order to determine the general quality and location of the hardwoods.

Timber supply analyses provided in this study are very preliminary in nature, and will require much additional work before site-specific opportunities can be confirmed. On a tentative basis, however, it appears that there are grounds for cautious optimism that forest industry development in northern Alberta can be expanded, perhaps significantly, using part of its currently underutilized hardwood resources.

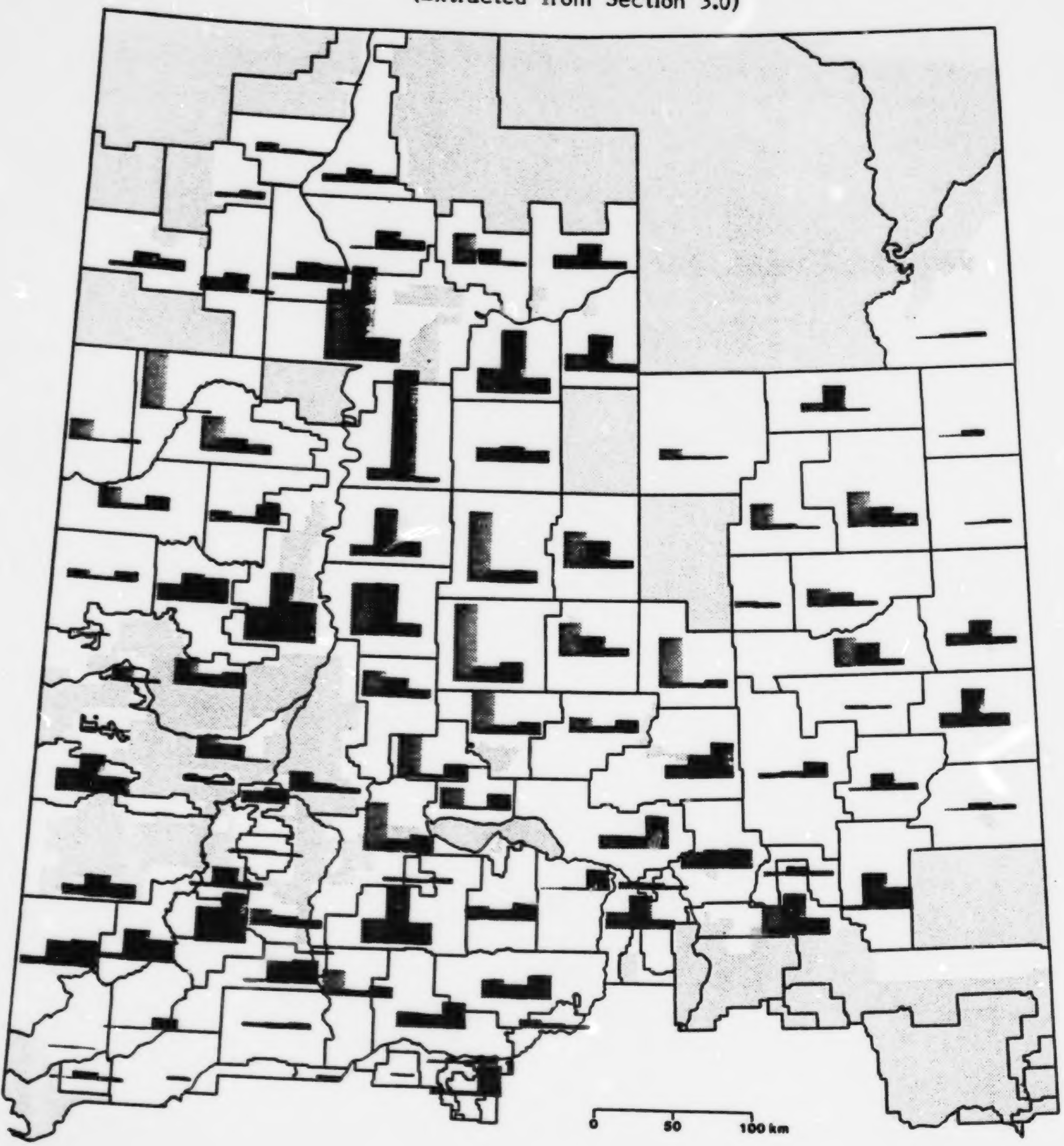
Specifically, the new forest inventory data indicate a fairly dramatic re-assessment of the distribution of hardwood supplies in northern Alberta, relative to the old allowable cut data. Higher hardwood volumes have been identified northwest of Slave Lake and lower concentrations east and south of Slave Lake. Encouragingly, the new data indicate a better age class distribution and large areas of young, healthy stands north and west of Slave Lake.

Young stands in some areas of Slave Lake and Whitecourt are believed to offer the best development opportunities. High volumes of aspen, generally with good age class distributions, have been identified in parts of the Peace River, Grande Prairie, Footner and Lac La Biche forests. They represent a potentially significant opportunity for hardwood manufacturing developments.

Map 4 taken from the main report is shown on the following page. The map displays the analyses of Phase III inventory data for pure stands of hardwood by age class distribution. Keeping in mind the earlier discussion on the potential for defect in older stands, the sub-merchantable quality of younger stands, the reader's attention is directed to the centre bar in each forest management unit graph--the merchantable stands.

Map 4

(Extracted from Section 3.0)



MAP 4
AREAS OF PURE HARDWOOD STANDS BY AGE CLASS

▨ 0 - 45 years (sub-merchantable)

▩ 50 - 75 years (merchantable, thrifty)

■ 80 years + (merchantable, decay-prone)

▬ 10,000 ha

◆ non - inventoried areas

The Potential for Producing A Wide Range of Hardwood-based Products Has Been Evaluated

A central objective of this study is to evaluate the new data in the light of product and market opportunities for more hardwood forest industry expansion in northern Alberta. A wide range of products options have been evaluated in terms of a) technical feasibility b) economic feasibility and c) market outlook. Each product option has been ranked in terms of 'high', 'moderate' or 'low' probability of success based on these criteria.

Pulp and Paper Options

Technically, it is possible to produce a very wide range of pulps and a variety of papers and paperboards from northern Alberta's hardwood species. Previous studies have reviewed most of these technical options and have dismissed many of them from further consideration because of market or economic limitations, or both. For the purposes of this study, a brief review of these ranking conclusions was carried out. The results generally verify the conclusions of the previous studies. However, additional market analysis carried out in this study, suggests that a slightly different ranking is justified in the ratings of the product options considered to have greatest investment potential for northern Alberta. Table 1 displays the results of our assessment.

Table 1

Preliminary Screening of Pulp and Paper Development Options

Short-listed Options	Technical	Economic	Market
Aspen bleached kraft pulp	H	L	H
Bleached CTMP	M-H	H	M-H
Uncoated woodfree papers	H	L	L
Uncoated groundwood papers	M	M	M-H*
Light weight coated paper	M	M-H	Very H
Tissues	L	L	L
Newsprint	L	L	M

L = low M = moderate H = high * longer term

Wood Product Options (stand alone)

The evaluation approach for wood product options is similar to that used for pulp and paper. The evaluation criteria are identical to those used for pulp and paper. However, only stand alone wood product options are considered. Integrated wood product options are discussed separately in the main report. Below in Table 2 is a summary of the options considered and the ranking on technical, economic, and market criteria.

Table 2

Preliminary Screening of Wood Product Development Options (Stand Alone)

Short-Listed Options	Technical	Economic	Market
Waferboard OSB	H	M/L	L
Construction Plywood	M	L	L
Medium Density Fiberboard	H	M/L	L
Particleboard	H	M/L	M/L
Specialty Plywood	M	M	M
Industrial Handling Lumber	H	M/L	L
Reconstituted Lumber	M	L	L
Specialty Lumber	H/M	M	H/M

L = low M = moderate H = high

Rating of Pulp and Paper and Wood Products Development Options

As a conclusion to the market assessment the short-listed pulp and paper development and solid wood product options are ranked in the table below in terms of most probable likelihood of success in northern Alberta. Obviously additional work is required to confirm these initial findings and to identify other relevant factors.

Northern Alberta: Ranking of Pulp & Paper* and Solid Wood Products Development Options

Most Promising

Aspen/Softwood CTMP
Lightweight Coated Paper (LWC)
Bleached Aspen-Kraft Market Pulp
Specialty Lumber

Longer Term Potential

Uncoated Groundwood Papers
Uncoated Woodfree Papers
Waferboard/OSB

Possible, But Not Given a High Ranking

Newsprint
Tissues

* Specialty pulp and paper products have not been considered.

Aspen Pulping Holds Considerable Promise

One of the principal conclusions of this study is that pulpmaking offers probably the best major development opportunity for utilizing the hardwood resources of northern Alberta. Two specific options have been evaluated as having a fairly high ranking for future manufacturing investment. These are aspen bleached kraft market pulp (aspen BKP) and aspen/spruce mix chemi-thermomechanical market pulp (aspen/spruce bleached CTMP). Aspen kraft pulping already has been tried on an experimental basis (Procter & Gamble at Grande Prairie) and the results apparently are encouraging. This technology fits best with existing experience and expertise in northern Alberta. It has a high ranking in terms of technical and market feasibility but the economic and financial viability of a greenfield mill is uncertain at this time.

Bleached CTMP, based on 50 per cent aspen/50 per cent spruce is a lower capital and operating cost option to kraft pulping. There are more locations in which it would be feasible in northern Alberta. The market prospects are good and the economic feasibility is potentially very high. This is a comparatively new, although proven process (a generally similar type exists in the B.C. Interior and an identical mill to the one identified for northern Alberta is being considered for Taylor, B.C.). However, it would require expertise which does not exist in Alberta at present. This option has the added advantage of potential feasibility as a stand-alone market pulp mill and scope for subsequent integration into paper/paperboard manufacturing either with existing or any new kraft pulp mill in the province.

Decay Levels Pose Some Constraints to Possible Pulp Mill Locations

The subject of decay, and its commercial implications, have been addressed in this study. The specific conclusions drawn from the analysis are as follows:

A. Aspen Bleached Kraft Market Pulp

Annual fibre requirements are in the order of 1.4 million cubic metres of roundwood (net of defect). Maximum decay levels in delivered wood are probably about 20 per cent, although levels approaching this would create substantial increases in logging and manufacturing costs. Small trees, which usually are more sound than larger/older trees, can be utilized. Water and infrastructure requirements are critical factors in facility location, and are not addressed in detail here.

Basing the selection of candidate areas simply on the distribution of AAC would indicate the highest concentration, and hence the best opportunity, in the eastern Slave Lake area (over two million cubic metres of AAC available within a 100 km radius), followed by Whitecourt and Grande Prairie (each having over one million cubic metres of AAC within 100 km.).

However, in view of the probable shift in AAC distribution discussed in more detail in Chapter 4, the availability of "non-forest" wood, and the situation regarding existing commitments, we suggest that the best opportunities may exist in the Peace River Forest, the area west of Slave Lake, or the Grande Prairie area.

The area west of Slave Lake appears to contain about one million cubic metres of AAC mostly within a 100 km. radius, with a good age-class distribution. Whereas in some of the eastern Slave Lake units we anticipate AAC's may be overly optimistic, the converse may be true for the area in question. In addition a significant supplemental volume could be acquired from the yellow area and Metis settlements. The hardwoods in the area are largely uncommitted. The biggest resource constraint for kraft development in the area presumably is water availability.

Grande Prairie ostensibly has over one million cubic metres of hardwood AAC within 100 km. However, some of the supply units contain significant components of older wood, supplemental sources are limited, and we do not know whether this cut level is achievable. Given that much of the available hardwood resource lies within their lease area, utilization here will depend very much on Procter and Gamble Ltd.

The Peace River area merits further examination. The most hopeful location would probably be downstream from the town of Peace River, perhaps at Manning. Current AAC estimates indicate about 840,000 cubic metres within 100 km. If the new inventory data are correct, this figure is probably not only attainable, but conservative. If these data are going to result in AAC increases anywhere in the Province, it will probably be in the Footner and Peace River management units on the east side of the Peace. These units would only be accessible to Manning during the winter, but a large supply of summer wood Could be attainable from the Procter and Gamble Reserve Area and supplementary sources. A very significant supply could be obtained from "non-forest" sources. Management unit PO3 alone contains at least 28 million cubic metres of standing inventory. Access to the Procter and Gamble Reserve Area would be a prerequisite for this option.

B. Aspen/Spruce Bleached CTMP

Annual fibre requirements are in the order of 260,000 cubic metres of hardwood, plus 240,000 cubic metres of softwood, which could be acquired in the form of residual chips from sawmill operations. Quality requirements are more stringent than for kraft, and we are assuming an upper decay limit of 10 per cent. Water requirement is only 5 per cent of that for kraft manufacture.

Several potential locations can be identified. We have preliminarily identified eight of these, and reviewed them with regard to the quantity of hardwood and of softwood chips economically available, existing tenurial commitments and utilization, and quality of the available hardwood.

Four locations have been retained as potentially feasible. These forest locations are Footner Lake, (Fort Vermilion), Peace River (Manning), Slave Lake (High Prairie Valleyview) and Grande Prairie. The Whitecourt and Slave Lake (East) locations have been provisionally rejected primarily because of anticipated decay problems. Adequate chip supplies are not readily available in the Fort McMurray and Lac La Biche areas. Facilities located in the Peace River or Grande Prairie areas would be at least partially dependent on lands over which P & G currently hold tenurial options.

Lightweight Coated Paper (LWC) Production Using Aspen Appears to be an Attractive Option

A number of important studies, financed or partially financed by the Departments of Economic Development and Energy and Natural Resources, recently have identified the potential for integrated production of papermaking in Alberta. Some of the conclusions are directly applicable to northern Alberta as a potential location of such plants.

The most promising papermaking option for northern Alberta is lightweight coated paper. This is used for magazines, catalogs and general printing. It is a growth market and Alberta has been considered as a possible location for a LWC plant by St. Regis Paper Co. which is a leader in this field.

On a technical and market basis, this option appears to be very feasible for northern Alberta: however, the comparative cost position of an Alberta based mill (compared with other possible Canadian and U.S. locations) has only been addressed at the general level in published studies. It is an option which the NADC should consider pursuing, subject to any existing negotiations which may be taking place at the senior government/corporate level vis a vis other possible locations in Alberta.

Other Papermaking Options Probably Could Not Be Considered For Some Time

Four other papermaking options are 'short-listed' in this study as potential development options for northern Alberta, using hardwoods. These are:

1. Uncoated Groundwood Papers
2. Uncoated Woodfree Papers
3. Newsprint
4. Tissues

Uncoated groundwood papers are used in similar applications to LWC papers (magazines, catalogs) and in business forms. The specific grade identified as having potential for northern Alberta is supercalendered groundwood which is a higher quality and higher priced product than some of the newsprint specialties produced by existing mills in western and eastern Canada. There are a number of unknowns relating to the feasibility of this development option for northern Alberta and it has been assessed as having longer term, rather than shorter term, potential.

Uncoated woodfree papers (photocopy, computer and office papers) would fit closely with the existing pulp industry structure in Alberta but there is a sizeable volume of overcapacity in North America at present. This is expected to continue for some time, despite significant market growth. Moreover, northern Alberta's competitive position is uncertain. This option also has been assessed as having longer term potential for northern Alberta.

Aspen newsprint has been produced on a trial basis by a number of companies (e.g. Prince Albert Pulp) and holds considerable longer term promise. However, it is not regarded as a significant option for the foreseeable future. Tissue production requires a strong domestic market opportunity to be viable. The technical feasibility for utilizing, in part, northern Alberta hardwoods is favourable, but this option has a low rating in terms of potential economic and market viability.

Lumber Specialties Offer Selective Development Opportunities

Construction grade aspen lumber is given a low rating on the basis of poor economics and weak market prospects. Industrial handling lumber (e.g. pallets) offers more potential, but is not given a high priority for successful new commercial development on a large scale in northern Alberta. Similar considerations apply to reconstituted products, such as laminated veneer lumber (LVL).

Specialty lumber options, based on aspen, have better potential. These comprise a wide range of products, such as turnings, panelling, shelving, furniture components, bedframes, mouldings and chopstick blanks. The technology to extract the necessary grades and sizes from aspen is readily available. Production economics frequently are variable and the most successful manufacturing operations (such as those in Ontario and the U.S. Lake States) emphasize the higher value-added products. Nevertheless, it should be recognized, in northern Alberta's case, that market for pulpable residuals will be critical. Much additional work is required before specific opportunities can be identified, but an encouraging development is the recent initiative by Canadian Forest Products Ltd. in Grande Prairie to develop market opportunities in aspen lumber specialty products in northern Alberta.

Smaller Scale Wood Product Development Options Could be Considered

It has already been pointed out that there does not appear to be any significant potential for new capacity to produce low value lumber for industrial handling. Higher value specialty products have better potential but are only economic if very high quality logs are used. Such logs are available on some sites but only on a selective basis. Furthermore they are often difficult to identify until the tree has been felled.

It is possible, therefore, that a number of small operators could exist if they were allowed to log on a very selective basis. From the resource management point-of-view this could, however, present some problems. Apart from provincial forestry policy considerations, there could be difficulties. Where the trees are within areas that have already been allocated (this would apply to much of the sites that are more easily accessed), the company with the existing allocation obviously is likely to resist losing the best trees. Even where the resource has yet to be allocated the existence of several small independents removing the best aspen could prove a negative factor to a potential larger investor.

It may be, however, that these difficulties can be overcome. The number of small operators can be limited and their volumes and areas of operation controlled so that any impact on large scale opportunities is minimized. Also it is worth noting that the large complexes such as pulp mills, or waferboard plants, are much more tolerant of variations in raw material quality than a small specialty lumber facility although there is still a cost involved. Thus while a pulp mill can, if necessary, use a great proportion of the qualities and sizes produced during logging, a specialty lumber operation, producing a high value product, can only be economic with the high quality log.

Assuming that the resource allocation aspect can be resolved, there is still likely to be a weakness at the production and marketing level. This type of operation is small and therefore has limited production sophistication and even less marketing expertise. Yet success in the manufacture of specialty products depends on

- consistent volumes and precise specifications
- extensive distribution and marketing since the products are designed for very specific markets.

It would be difficult for an individual small operator to satisfy these requirements alone, and the key to development appears to be in a cooperative marketing and distribution arrangement, perhaps assisted through regional development funding.

Despite Considerable Potential, A Number of Serious Constraints to Development Exist

One of the keys to successful economic expansion of the unutilized portions of the forest resources of northern Alberta is the development of an adequate transportation infrastructure. In many respects, however, this is a "chicken-and-egg" situation. On one hand, development of the full potential cannot be achieved without a) adequate physical infrastructure and b) the availability of rail/truck service offering a competitive rate structure for shipment of product. On the other hand, the economic provision of the physical infrastructure, beyond that which exists today, and the development of a competitive rate structure (e.g. rail) depends on the existence, or potential development, of a viable industrial base.

This study has indicated a reasonably favourable aspen resource situation in, for example, the Fort Vermilion area, yet the nearest rail point is at High Level. There are many similar examples. It is not possible, because of the general nature of this study, to conclude that the absence of an adequate physical infrastructure is the major factor precluding an industrial development. This would require site-specific study. Nevertheless, a basic principle can be identified. This is that for industrial development to proceed in these circumstances, realistically there must be public sector participation in the costs involved.

The detailed analysis of transportation rates, again, is beyond the scope of this study. In some areas there is a choice of transportation modes, but no choice in others. De-regulation of rail transportation in the U.S. is having a dramatic impact upon freight rates and service in North America and, in almost all cases, rates are now directly negotiated between carrier and shipper.

Transportation distances, road haulage weight allowances and transportation cost have been cited in some cases as negative factors affecting the viability of potential forest industry investments in northern Alberta. Any of these may be valid claims. It simply is not possible, in a study such as this, to identify any broad transportation-related constraints which may be precluding new forest product manufacturing investment in the area.

There are other serious and diverse constraints to development. First among these is the issue of business climate. A good business climate is conducive to new investment: a poor one obviously is not. There are two aspects of business climate. The first aspect is the existing image of an area such as northern Alberta (and more generally of Alberta and, in turn, Canada) for forest products investment. The second aspect is related to information. It involves the identification of specific investment potential and it's active promotion through business development.

Business climate is an intangible but very important factor in determining the attractiveness of an area for new capital investment. It is a particularly strong factor where investment is being considered by companies based outside Alberta, on either a direct or joint-venture basis.

Fewer Studies Are Needed: and More Promotion is Required

Alberta scores very well in producing information and studies related to aspen potential. The evidence for this is the extensive number of literature citations contained in the appendices to this study. Alberta scores less favourably, however, in the identification and active promotion of specific investment options.

It should be recognized that in the past few years, many competing supply areas to northern Alberta have taken some unprecedented steps to attract new investments into their areas and to encourage existing industry to expand in higher value-added products. These steps include a wide range of incentives ranging from information packages for specific sectors (e.g. quantifying favourable investment conditions) to comprehensive financial and taxation treatment. Examples include some U.S. states and many overseas countries.

In the pulp and paper industry specifically, there has been a major and positive shift in the attitude of local and state/provincial governments to this sector compared with a decade ago. In the buoyant demand conditions of the early 1970's, when very favourable growth rates were anticipated to continue for a wide range of products, it was comparatively easy to attract new investment. Today, the situation has been reversed. Companies seeking expansion are faced with tough competitive conditions. They are selective in their investments and they are attracted to those areas which offer the greatest potential for success and which minimize the business risks inherent in new ventures.

Areas which offer the best investment climate usually are the first to attract new investment. Canada's recent history has not been good in this respect and, compared with earlier decades, only a limited amount of new investment has taken place in the forest products industry over the past ten years. It appears probable, that unless this changes, much of the potential for forest products production in northern Alberta may not be realized.

For Some Product Opportunities, The Lack of External Economies is a Constraint

Any region which has an established industrial structure in a particular technology, normally offers certain advantages to complementary industries commencing operations in the area. These external economies include an established labour force in the technology in question; management skills and various other factors such as an established infrastructure (e.g. suitable rail stock for shipping comparatively high valued papers); an established distribution network and so on. In this regard, regions such as British Columbia have external economies in bleached softwood kraft and newsprint. The U.S. Midwest has external economies in LWC papers and the U.S. Northeast (non-integrated) and U.S. South (integrated) in u/c woodfree papers. The existence of these factors enhances the relative attractiveness of one region over another for new related investment.

Northern Alberta's external economies in forest products are limited. At present they include items such as softwood lumber, waferboard and market pulp. For some of the new product opportunities identified in this study, the limited external economies which exist in northern Alberta are not necessarily an unsolvable problem providing that at least some of these factors (e.g. key trained operating personnel and management) can be brought into the region by an established producer of such grades from another region, or where such skills can be obtained through joint-venture, or affiliate, arrangements involving the producer and paper maker/paper user.

In another respect, however, northern Alberta does have reasonably good future prospects as far as development of its existing product base and related new products (e.g. market pulp) are concerned. The region already has a well established lumber, waferboard and bleached kraft pulp industry and most of the highly rated forest product development options identified in this study capitalize on these existing strengths.

An Aggressive Approach to Development Promotion is Necessary...

It is recommended that the NADC should direct its future policies for forest products development towards the active promotion of the aspen-based products short-listed earlier in this Executive Summary. These are the ones which will optimize northern Alberta's comparative strengths (competitive wood costs, its fibre resource quality and Alberta's plentiful supplies of low cost energy, compared with areas such as the U.S.).

...But Only After Development Strategies Have Been Carefully Considered

It is essential that before active promotion is undertaken, the NADC should coordinate this process with initiatives being undertaken by provincial government departments. Specifically, possible locations for an LWC plant (one of the options available to northern Alberta) have been discussed also in southern Alberta. Clearly, uncoordinated active promotion of the same development option, in say the U.S., by two or more organizations from Alberta would have an adverse impact on Alberta's chances of success.

Once Decided, These Strategies Should be Pursued Consistently

Experience in areas seeking development in forest products has shown that success normally is greatest where a) viable development options have been correctly identified before development initiatives have been undertaken and b) where the development authority has not tried to be "all things to all men." It is the responsibility of the NADC to satisfy itself that a) has been adequately researched. Subsequently, with respect to b), it will be imperative to be consistent in promoting the product options in which northern Alberta will be claiming it can offer very competitive and attractive investment conditions.

Even So, Development Will Be Gradual

Even under optimum business climate conditions in northern Alberta, it should be recognized that future expansion of the forest products industry in northern Alberta would be gradual. A few of the product options appear to have immediate investment potential, as discussed earlier, and the employment and income implications could be significant. Most others are medium to longer term. Clearly, it is possible, through special measures and incentive programs, to bring forward some of these medium and longer term options, as discussed earlier.

Three broad criteria have been used to evaluate potential development options (i.e. technical feasibility; economic feasibility and market outlook). In product options identified, northern Alberta varies in its ability to compete with other areas on each criterion. Moreover, many product options have been researched only at a general level and more specific targetting of future study work is required.

For general planning purposes, however, the very approximate timing of aspen-related forest products development in northern Alberta, under current assumptions, can be summarized as follows:

APPROX. TIMING OF FOREST PRODUCT DEVELOPMENT OPTIONS FOR NORTHERN ALBERTA

Period	Investment Options which Could Prove Viable
1985-1990	Aspen/Spruce Bleached CTMP
"	Light Weight Coated (LWC) Paper
"	Specialty Lumber Operations
1990-2000	Aspen Bleached Kraft Market Pulp
"	Uncoated Groundwood Papers
"	Waferboard/OSB
Beyond the year 2000	All Other Short-listed Investment Options

Some Immediate Initiatives Should Be Considered

In order to facilitate the early development of the highly ranked forest product options in northern Alberta, three specific initiatives should be considered. These are:

1. Aspen Harvesting Policy

The government of Alberta has developed a flexible and negotiable approach to forestry development. Whilst the maintenance of this flexibility is desirable, some clarification of harvesting policy and resource availability is necessary in order that viable development options can be correctly identified.

Hardwood AAC's should be recalculated at the earliest opportunity, taking into account age class distribution, decay-age trends, and softwood harvest schedules. This should facilitate realistic identification of areas with potential for viable economic development.

In areas defined as having good potential, more detailed clarification of policy is necessary as a prerequisite to the promotion of targeted product-market opportunities. The availability of these forest lands for both long term and short term hardwood utilization should be clarified in relation to alternative uses such as softwood production and agriculture. In recognition of the fact that only a proportion of existing stocks are likely to be successfully utilized, it will be necessary to realistically define (in terms of accessibility and quality):

1. what components of the resource operators will be obliged to utilize,
2. what components will be recognized as unusable,
3. what obligations the public and private sectors have to rehabilitate unusable stands, and
4. how local discontinuities in supply (resulting from age class imbalances) may be accommodated.

2. Promotional Package

It is recommended that, when its development strategies have been determined, the NADC (in coordination with the provincial and the federal government) should consider the preparation of a promotional package specifically for forest industry development (involving available softwood and hardwood resources) targetted to specific product-market opportunities.

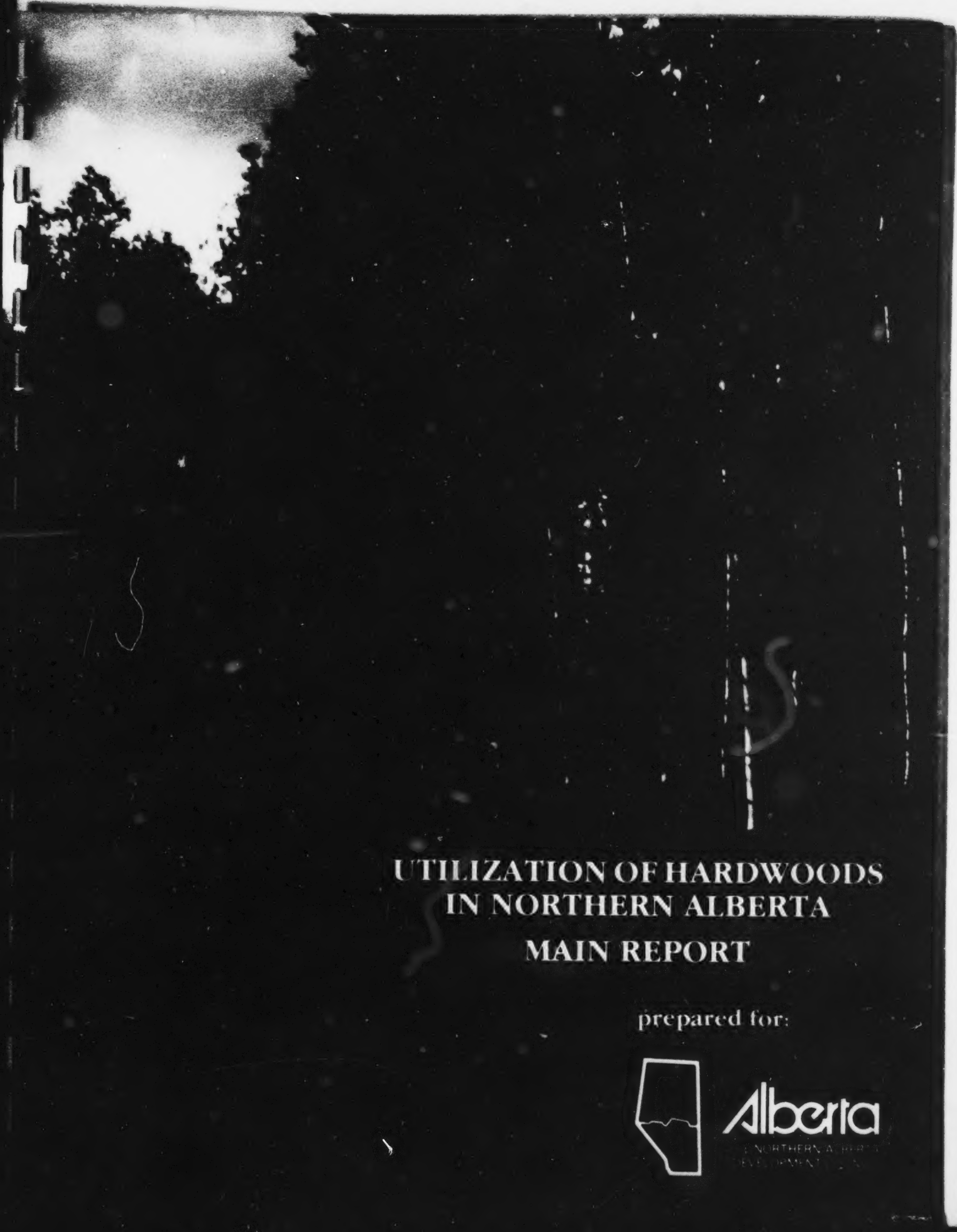
Various examples of successful promotional packages prepared for areas outside Alberta have been discussed with the NADC and the Steering Committee. They are principally designed to inform potential investors. The issue of the possible need for industrial incentives has been raised by the Committee. This issue is outside the scope of this report. Such incentives may be found to be necessary, but it is suggested that a) the need and b) the extent of any incentives should be determined independently of this report.

3. Active Marketing to Potential Investors

A program of active marketing should be developed, in consultation with, or carried out by, the provincial government. This could arise out of the recently signed Canada-Alberta Forest Resource Development Agreement and should continue over a 4 to 5 year period.

Number/
Numéro

2



UTILIZATION OF HARDWOODS IN NORTHERN ALBERTA

MAIN REPORT

prepared for:

Alberta
NORTHERN ALBERTA
DEVELOPMENT COUNCIL

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Consultants in Forest Industry Economics

P.334

March 5, 1985

Mr. Rick Sloan
Senior Northern Development Officer
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Peace River, Alberta T0H 2X0

Dear Mr. Sloan

Letter of Transmittal

I am pleased to present our report on the utilization of hardwoods in northern Alberta. Throughout the preparation of the report we received excellent cooperation from you and your staff and I would like to add a special note of thanks also to the Steering Committee whose guidance and helpful comments were of great assistance.

Specifically the members of the Steering Committee and their affiliations are:

Dr. Suezone Chow, Canadian Forest Products Ltd, Vancouver, B.C.
Mr. Terry Barr, Procter & Gamble Cellulose, Grande Prairie
Mr. Norman Anderson, Weldwood of Canada Ltd., Slave Lake
Mr. Brian Karaim, Alberta Energy & Natural Resources, Edmonton
Mr. Richard Anderson, Alberta Economic Development, Edmonton
Mr. Rick Sloan, Northern Development Branch, Peace River

We trust that the Northern Alberta Development Council will find the report to be interesting and useful in contributing to the realization of the aspen-based development opportunities which exist in northern Alberta.

Yours sincerely,

for

Peter Woodbridge

PW:jh
Encl.

UTILIZATION OF HARDWOODS IN NORTHERN ALBERTA

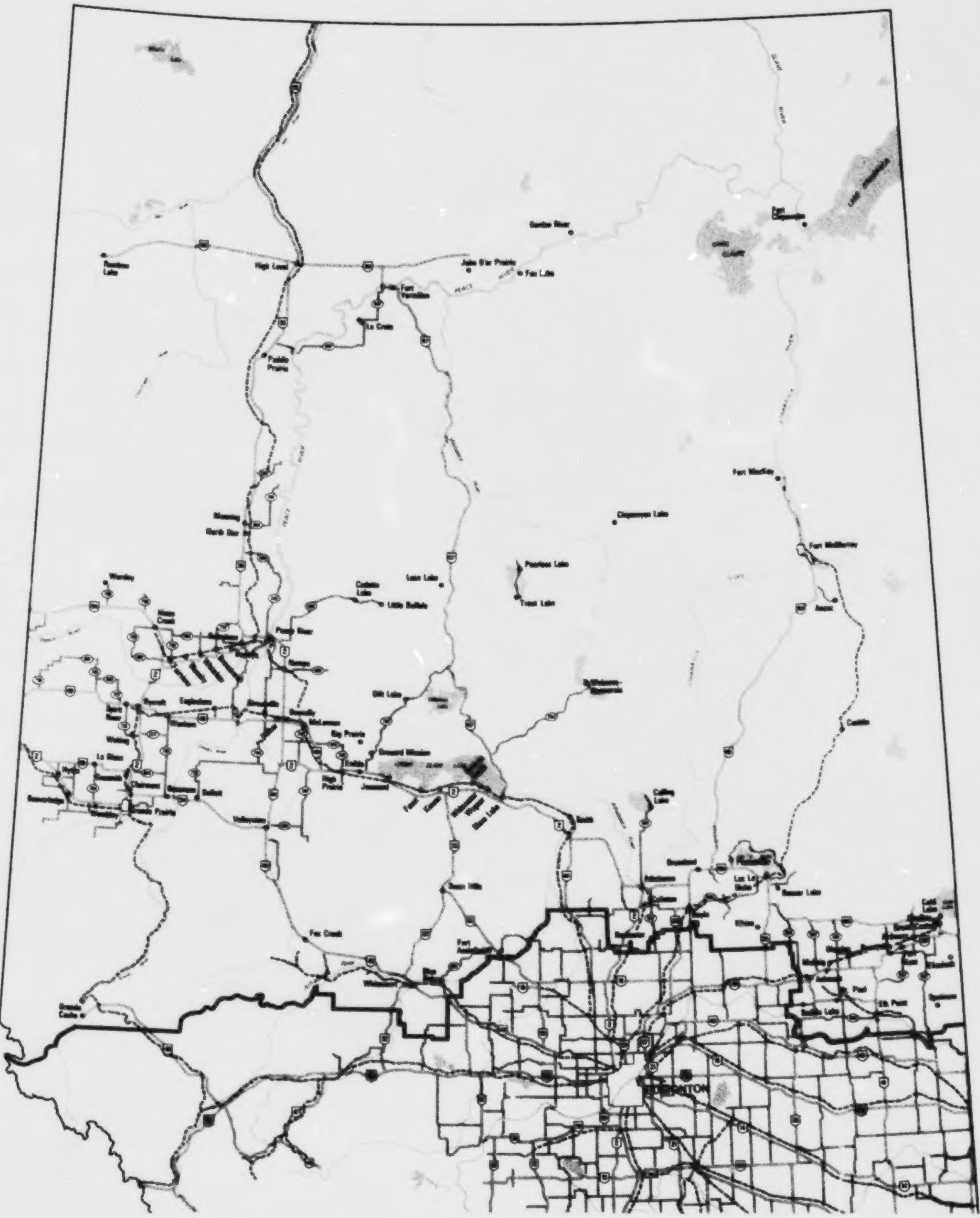
MAIN REPORT

Prepared for: Northern Alberta Development Council

Prepared by: Woodbridge, Reed and Associates Ltd.
A Division of H.A. Simons (International) Ltd.
Vancouver, B.C.

February, 1985

The cost of this report has been jointly shared between the Northern Development Branch of Alberta Tourism and Small Business, and the Forest Products and Forest Industrial Development Research Program (Alberta Economic Development, Alberta Energy and Natural Resources and the Alberta Research Council).



Rainbow Lake
High Level
John D'Or Prairie
Fox Lake
Fort Vermilion
La Crete
Paddle Prairie
Garden River
Fort Chipewyan
Fort MacKay
Fort McMurray
Chipewyan Lake
Peerless Lake
Trout Lake
Cadotte Lake
Little Buffalo
Loon Lake
Manning
Peace River
Big Prairie
Grouard Mission
High Prairie
Slave Lake
Fox Creek
Swan Hills
Calling Lake
Lac La Biche
Grande Cache
EDMONTON

NORTHERN ALBERTA DEVELOPMENT COUNCIL AREA

COMMUNITIES WITH POPULATION OVER 75 (1981 CANADA CENSUS)

km 10 0 10 20 30 40 50 60 70 km
miles 10 0 10 20 30 40 50 miles

PRIMARY HIGHWAY   SECONDARY ROAD   RAILWAY

PRODUCED BY THE ALBERTA BUREAU OF SURVEYING AND MAPPING © 1983

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SUMMARY

Alberta's Fibre Reserves in the Global Context

In the past decade, there has been a great deal of discussion about the prospect of global deficits in economically accessible supplies of softwood and hardwood timber. This has caused concern in some major traditional supplying areas, such as Canada, where it was assumed that the softwood timber reserve was much greater. The other side of the picture, however, has been an increased level of interest in "fibre supply" potential from (a) "new" supplying areas (particularly in plantation developments, e.g. Brazil, South Africa, Chile, etc.) and (b) areas of timber previously considered to be marginal by virtue of location, stand-densities, species, timber quality and so on.

In the late 1970's, Alberta certainly justified a position on most timber companies' "shopping-lists" as an area for expansion. Significantly Alberta's estimated 17 million cubic metre reserve represents the largest incremental wood supply in all of Canada. Given the recent recession, however, the immediate outlook for many companies is for priorities to be placed on upgrading of existing facilities in currently committed areas.

The analysis presented in this study indicates that Alberta still can offer competitive strengths in a number of important aspects. The reality is that the comparative attractiveness of these factors has to be viewed in the context of a much more competitive climate for new investment. Development of these resources is not so much a question of "if" as "when".

Current Utilization of Hardwoods in Alberta

There is, as of 1984, one waferboard plant and one OSB (Oriented Strand Board) plant in Alberta using aspen as their raw material. The waferboard plant is located at Slave lake. In 1979 the plant was purchased by Weldwood and extensive modernization was carried out. The plant commenced full operation in 1981 and has been producing waferboard since that time with a few temporary closures due to poor market conditions.

The OSB plant at Edson is of much more recent origin. It commenced full operation in 1984 and is a very modern plant with state-of-the-art technology producing a high quality product.

Apart from these two major facilities, hardwood logs are also utilized by a number of small sawmills. In total there are about 25 mills on record as cutting aspen. However, a number of these are very small and only operate on a sporadic basis producing less than one million board feet annually. Their products tend to be utilized very locally for construction purposes or are sold for a variety of low value uses such as pipe racks, dunnage and pallets.

Hardwood utilization for pulp in Alberta currently is limited to experimental volumes for aspen bleached kraft market pulp (BKP) at Procter & Gamble's Grande Prairie softwood bleached kraft market pulp. A specialty pulp/paper mill utilizing aspen has been proposed by Makin for the Drayton Valley area.

The Hardwood Species in Northern Alberta

Three species of hardwood grow to commercial size in northern Alberta: trembling aspen, balsam poplar and white birch. Trembling aspen is the most numerous of the three in Alberta. In fact, it is the most widely distributed tree species in North America. A major constraint to utilization in northern Alberta is that essentially the same type of resource occurs in many locations closer to some major North American population centres.

The extensive occurrence of aspen is in large part a result of its successful ability to regenerate through root suckering. This allows reestablishment after fire, logging, insects or disease have caused death of the overstory, as long as the root system has not been killed. It is also well adapted to extensive forest management, where the forester wishes to re-establish growth and stocking as quickly and inexpensively as possible after clear-cutting.

Balsam poplar, like aspen, is an early successional species with striking capabilities to reproduce naturally through root suckers or stump sprouts after disturbance. While the species is common, it is much less abundant than aspen. It is often found intimately mixed with aspen, a situation which is problematic for existing panelboard operations in Alberta which currently utilize only aspen. White birch is the least abundant of the three hardwood species.

Defect in the Hardwood Resource

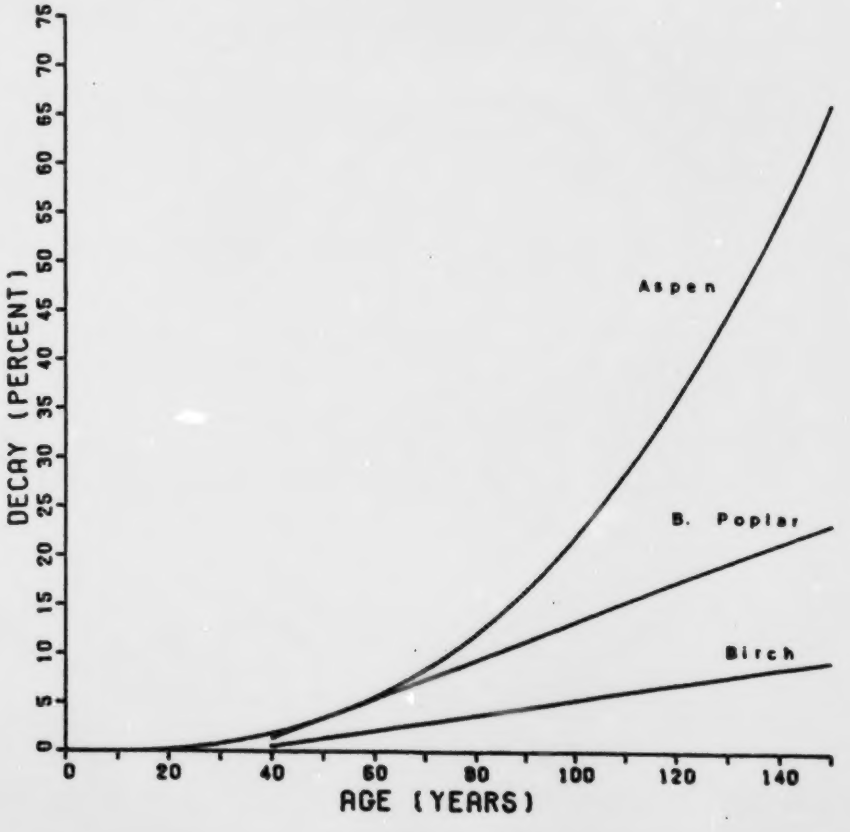
Trembling aspen and balsam poplar are subject to a number of decay diseases which cause timber loss and degradation of wood quality. Decay is of paramount importance in any consideration of hardwood utilization in northern Alberta. The most frequently reported decay organism in northern Alberta is **Fomes igniarius**, often referred to as white heart rot or white trunk rot. It is more prevalent in aspen than in balsam poplar. The rot enters the trunk of the tree through wounds such as where branches have broken off or where frost cracks have opened the bark. Infection goes through several stages including stain (where the wood is discoloured but the structural integrity is maintained), through incipient or intermediate decay (when the cell walls making up the wood are beginning to break down), to advanced decay (when the wood is soft and visibly decomposed).

Although the significance of decay to commercial development of the resource is accepted, our ability to predict the extent of decay in existing or future hardwood stands is poor. In this study, we attempted to relate the percentage of decayed wood to stand age. Relating decay to other site variables was considered futile at this time, either because research had failed to quantify the relationship or because Alberta inventory data did not include the potential indicator variables.

In order to construct a simple mathematical model which could be used to predict decay levels from forest inventory projections, various formulae were manipulated until curves were obtained which seemed to best represent the relationship between decay and age. Given the amount of variation observed in the literature and in production experience, the selection of such curves was necessarily subjective and the resulting predictions will obviously deviate widely from the actual cull percentages encountered in many specific situations. Figure 1 summarizes these predictions. Note the exponential increase in decay forecast for aspen. The stand is considered effectively "broken-up" and unusable by 140 years of age, when the decay percentage exceeds 50 per cent.

Figure 1
(Extracted from Section 2.0)

Percentage of Decayed Volume Predicted in Relation to Age for Aspen, Balsam Poplar and Birch



A central implication then, on the resource side of the utilization question, is that decay is unpredictably distributed throughout the tree in such a way that, although only 10 to 20 per cent of the wood might be rotten, loggers and manufacturers experience great difficulty in economically recovering the sound wood.

This means that many of the aspen trees in northern Alberta are either already too old and decayed to be utilized or are presently too small. Timing is critical in the successful utilization of the species and the logistic difficulties of harvesting the trees when they are large enough for manufacture, but before they succumb to decay, are not easily overcome.

The Phase III Inventory

The Alberta Forest Service has just completed a major assessment of the province's timber resources. This has provided the best, publicly available, assessment so far of Alberta's hardwoods. For the purposes of this study, analysis of these new data has been carried out in order to determine the general quality and location of the hardwoods.

Timber supply analyses provided in this study are very preliminary in nature, and will require much additional work before site-specific opportunities can be confirmed. On a tentative basis, however, it appears that there are grounds for cautious optimism that forest industry development in northern Alberta can be expanded, perhaps significantly, using part of its currently underutilized hardwood resources.

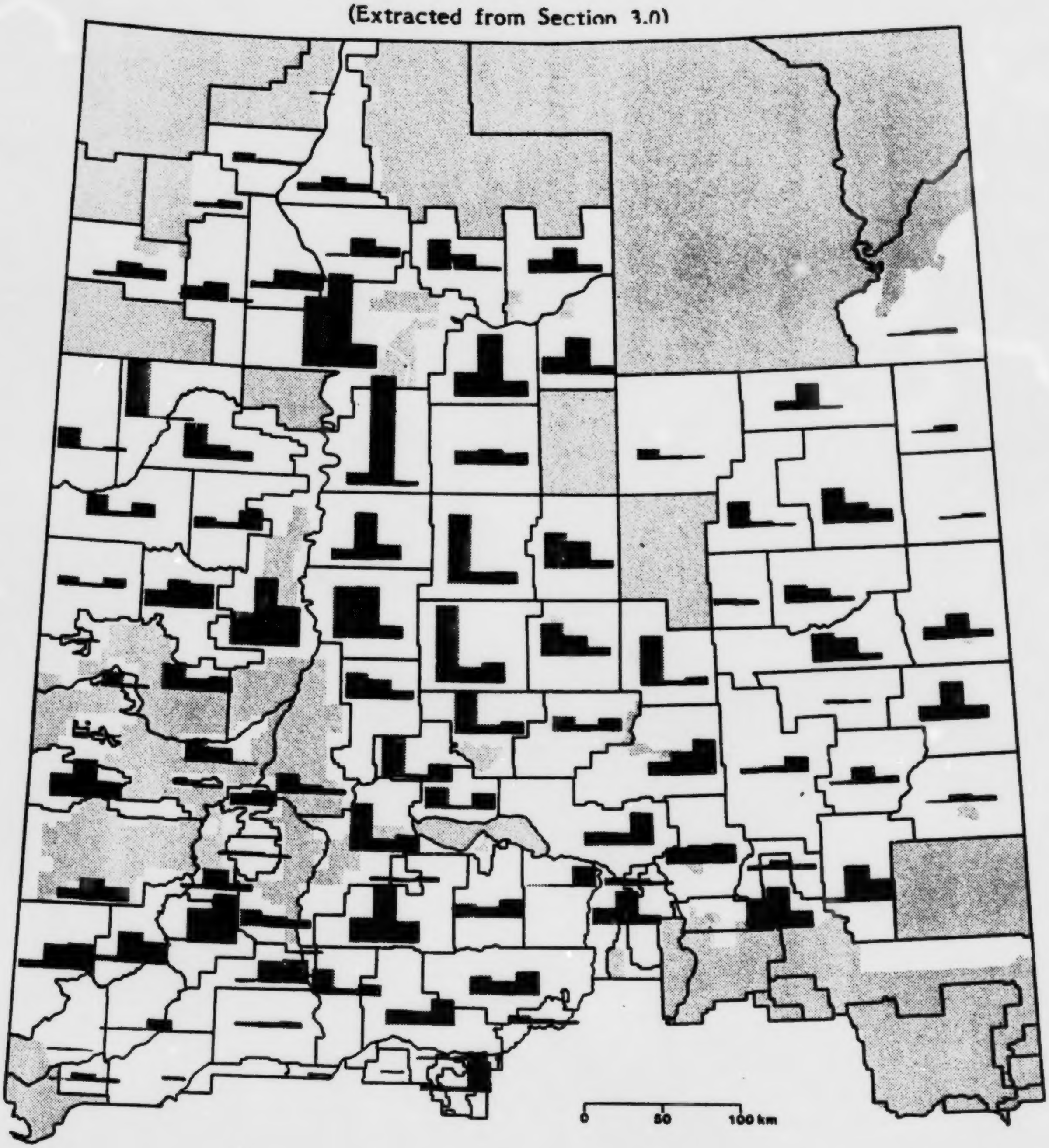
Specifically, the new forest inventory data indicate a fairly dramatic re-assessment of the distribution of hardwood supplies in northern Alberta, relative to the old allowable cut data. Higher hardwood volumes have been identified northwest of Slave Lake and lower concentrations east and south of Slave Lake. Encouragingly, the new data indicate a better age class distribution and large areas of young, healthy stands north and west of Slave Lake.

Young stands in some areas of Slave Lake and Whitecourt are believed to offer the best development opportunities. High volumes of aspen, generally with good age class distributions, have been identified in parts of the Peace River, Grande Prairie, Footner and Lac La Biche forests. They represent a potentially significant opportunity for hardwood manufacturing developments.

Map 4 taken from section 3.0 of this report is shown on the following page. The map displays the analyses of Phase III inventory data for pure stands of hardwood by age class distribution. Keeping in mind the earlier discussion on the potential for defect in older stands, the sub-merchantable quality of younger stands, the reader's attention is directed to the centre bar in each forest management unit graph--the merchantable stands.

Map 4

(Extracted from Section 3.0)



MAP 4

AREAS OF PURE HARDWOOD STANDS BY AGE CLASS

■ 0 - 45 years (sub-merchantable)
■ 50 - 75 years (merchantable, thrifty)
■ 80 years + (merchantable, decay-prone)
▬ 10,000 ha
◆ non-inventoried areas

The Potential for Producing A Wide Range of Hardwood-based Products Has Been Evaluated

A central objective of this study is to evaluate the new data in the light of product and market opportunities for more hardwood forest industry expansion in northern Alberta. A wide range of products options have been evaluated in terms of a) technical feasibility b) economic feasibility and c) market outlook. Each product option has been ranked in terms of 'high', 'moderate' or 'low' probability of success based on these criteria.

Pulp and Paper Options

Technically, it is possible to produce a very wide range of pulps and a variety of papers and paperboards from northern Alberta's hardwood species. Previous studies have reviewed most of these technical options and have dismissed many of them from further consideration because of market or economic limitations, or both. For the purposes of this study, a brief review of these ranking conclusions was carried out. The results generally verify the conclusions of the previous studies. However, additional market analysis carried out in this study, suggests that a slightly different ranking is justified in the ratings of the product options considered to have greatest investment potential for northern Alberta. Table S-1 displays the results of our assessment.

Table S-1

Preliminary Screening of Pulp and Paper Development Options

Short-listed Options	Technical	Economic	Market
Aspen bleached kraft pulp	H	L	H
Bleached CTMP	M-H	H	M-H
Uncoated woodfree papers	H	L	L
Uncoated groundwood papers	M	M	M-H*
Light weight coated paper	M	M-H	Very H
Tissues	L	L	L
Newsprint	L	L	M

L = low M = moderate H = high * longer term

Wood Product Options (stand alone)

The evaluation approach for wood product options is similar to that used for pulp and paper. The evaluation criteria are identical to those used for pulp and paper. However, only stand alone wood product options are considered. Integrated wood product options are discussed separately in later sections. Below in Table S-2 is a summary of the options considered and the ranking on technical, economic, and market criteria.

Table S-2

Preliminary Screening of Wood Product Development Options
(Stand Alone)

Short-Listed Options	Technical	Economic	Market
Waferboard OSB	H	M/L	L
Construction Plywood	M	L	L
Medium Density Fiberboard	H	M/L	L
Particleboard	H	M/L	M/L
Specialty Plywood	M	M	M
Industrial Handling Lumber	H	M/L	L
Reconstituted Lumber	M	L	L
Specialty Lumber	H/M	M	H/M

L = low M = moderate H = high

Rating of Pulp and Paper and Wood Products Development Options

As a conclusion to the market assessment the short-listed pulp and paper development and solid wood product options are ranked in the table below in terms of most probable likelihood of success in northern Alberta. Obviously additional work is required to confirm these initial findings and to identify other relevant factors.

Northern Alberta: Ranking of Pulp & Paper* and Solid Wood Products Development Options

Most Promising
Aspen/Softwood CTMP
Lightweight Coated Paper (LWC)
Bleached Aspen-Kraft Market Pulp
Specialty Lumber

Longer Term Potential
Uncoated Groundwood Papers
Uncoated Woodfree Papers
Waferboard/OSB

Possible, But Not Given a High Ranking
Newsprint
Tissues

* Specialty pulp and paper products have not been considered.

Aspen Pulping Holds Considerable Promise

One of the principal conclusions of this study is that pulpmaking offers probably the best major development opportunity for utilizing the hardwood resources of northern Alberta. Two specific options have been evaluated as having a fairly high ranking for future manufacturing investment. These are aspen bleached kraft market pulp (aspen BKP) and aspen/spruce mix chemi-thermomechanical market pulp (aspen/spruce bleached CTMP). Aspen kraft pulping already has been tried on an experimental basis (Procter & Gamble at Grande Prairie) and the results apparently are encouraging. This technology fits best with existing experience and expertise in northern Alberta. It has a high ranking in terms of technical and market feasibility but the economic and financial viability of a greenfield mill is uncertain at this time.

Bleached CTMP, based on 50 per cent aspen/50 per cent spruce is a lower capital and operating cost option to kraft pulping. There are more locations in which it would be feasible in northern Alberta. The market prospects are good and the economic feasibility is potentially very high. This is a comparatively new, although proven process (a generally similar type exists in the B.C. Interior and an identical mill to the one identified for northern Alberta is being considered for Taylor, B.C.). However, it would require expertise which does not exist in Alberta at present. This option has the added advantage of potential feasibility as a stand-alone market pulp mill and scope for subsequent integration into paper/paperboard manufacturing either with existing or any new kraft pulp mill in the province.

Decay Levels Pose Some Constraints to Possible Pulp Mill Locations

The subject of decay, and its commercial implications, have been addressed in this study. The specific conclusions drawn from the analysis are as follows:

A. Aspen Bleached Kraft Market Pulp

Annual fibre requirements are in the order of 1.4 million cubic metres of roundwood (net of defect). Maximum decay levels in delivered wood are probably about 20 per cent, although levels approaching this would create substantial increases in logging and manufacturing costs. Small trees, which usually are more sound than larger/older trees, can be utilized. Water and infrastructure requirements are critical factors in facility location, and are not addressed in detail here.

Basing the selection of candidate areas simply on the distribution of AAC would indicate the highest concentration, and hence the best opportunity, in the eastern Slave Lake area (over two million cubic metres of AAC available within a 100 km radius), followed by Whitecourt and Grande Prairie (each having over one million cubic metres of AAC within 100 km.).

However, in view of the probable shift in AAC distribution discussed in more detail in Chapter 4, the availability of "non-forest" wood, and the situation regarding existing commitments, we suggest that the best opportunities may exist in the Peace River Forest, the area west of Slave Lake, or the Grande Prairie area.

The area west of Slave Lake appears to contain about one million cubic metres of AAC mostly within a 100 km. radius, with a good age-class distribution. Whereas in some of the eastern Slave Lake units we anticipate AAC's may be overly optimistic, the converse may be true for the area in question. In addition a significant supplemental volume could be acquired from the yellow areà and Metis settlements. The hardwoods in the area are largely uncommitted. The biggest resource constraint for kraft development in the area presumably is water availability.

Grande Prairie ostensibly has over one million cubic metres of hardwood AAC within 100 km. However, some of the supply units contain significant components of older wood, supplemental sources are limited, and we do not know whether this cut level is achievable. Given that much of the available hardwood resource lies within their lease area, utilization here will depend very much on Procter and Gamble Ltd.

The Peace River area merits further examination. The most hopeful location would probably be downstream from the town of Peace River, perhaps at Manning. Current AAC estimates indicate about 840,000 cubic metres within 100 km. If the new inventory data are correct, this figure is probably not only attainable, but conservative. If these data are going to result in AAC increases anywhere in the Province, it will probably be in the Footner and Peace River management units on the east side of the Peace. These units would only be accessible to Manning during the winter, but a large supply of summer wood Could be attainable from the Procter and Gamble Reserve Area and supplementary sources. A very significant supply could be obtained from "non-forest" sources. Management unit PO3 alone contains at least 28 million cubic metres of standing inventory. Access to the Procter and Gamble Reserve Area would be a prerequisite for this option.

B. Aspen/Spruce Bleached CTMP

Annual fibre requirements are in the order of 260,000 cubic metres of hardwood, plus 240,000 cubic metres of softwood, which could be acquired in the form of residual chips from sawmill operations. Quality requirements are more stringent than for kraft, and we are assuming an upper decay limit of 10 per cent. Water requirement is only 5 per cent of that for kraft manufacture.

Several potential locations can be identified. We have preliminarily identified eight of these, and reviewed them with regard to the quantity of hardwood and of softwood chips economically available, existing tenurial commitments and utilization, and quality of the available hardwood.

Four locations have been retained as potentially feasible. These forest locations are Footner Lake, (Fort Vermilion), Peace River (Manning), Slave Lake (High Prairie Valleyview) and Grande Prairie. The Whitecourt and Slave Lake (East) locations have been provisionally rejected primarily because of anticipated decay problems. Adequate chip supplies are not readily available in the Fort McMurray and Lac La Biche areas. Facilities located in the Peace River or Grande Prairie areas would be at least partially dependent on lands over which P & G currently hold tenurial options.

Lightweight Coated Paper (LWC) Production Using Aspen Appears to be an Attractive Option

A number of important studies, financed or partially financed by the Departments of Economic Development and Energy and Natural Resources, recently have identified the potential for integrated production of papermaking in Alberta. Some of the conclusions are directly applicable to northern Alberta as a potential location of such plants.

The most promising papermaking option for northern Alberta is lightweight coated paper. This is used for magazines, catalogs and general printing. It is a growth market and Alberta has been considered as a possible location for a LWC plant by St. Regis Paper Co. which is a leader in this field.

On a technical and market basis, this option appears to be very feasible for northern Alberta: however, the comparative cost position of an Alberta based mill (compared with other possible Canadian and U.S. locations) has only been addressed at the general level in published studies. It is an option which the NADC should consider pursuing, subject to any existing negotiations which may be taking place at the senior government/corporate level vis a vis other possible locations in Alberta.

Other Papermaking Options Probably Could Not Be Considered For Some Time

Four other papermaking options are 'short-listed' in this study as potential development options for northern Alberta, using hardwoods. These are:

1. Uncoated Groundwood Papers
2. Uncoated Woodfree Papers
3. Newsprint
4. Tissues

Uncoated groundwood papers are used in similar applications to LWC papers (magazines, catalogs) and in business forms. The specific grade identified as having potential for northern Alberta is supercalendered groundwood which is a higher quality and higher priced product than some of the newsprint specialties produced by existing mills in western and eastern Canada. There are a number of unknowns relating to the feasibility of this development option for northern Alberta and it has been assessed as having longer term, rather than shorter term, potential.

Uncoated woodfree papers (photocopy, computer and office papers) would fit closely with the existing pulp industry structure in Alberta but there is a sizeable volume of overcapacity in North America at present. This is expected to continue for some time, despite significant market growth. Moreover, northern Alberta's competitive position is uncertain. This option also has been assessed as having longer term potential for northern Alberta.

Aspen newsprint has been produced on a trial basis by a number of companies (e.g. Prince Albert Pulp) and holds considerable longer term promise. However, it is not regarded as a significant option for the foreseeable future. Tissue production requires a strong domestic market opportunity to be viable. The technical feasibility for utilizing, in part, northern Alberta hardwoods is favourable, but this option has a low rating in terms of potential economic and market viability.

Lumber Specialties Offer Selective Development Opportunities

Construction grade aspen lumber is given a low rating on the basis of poor economics and weak market prospects. Industrial handling lumber (e.g. pallets) offers more potential, but is not given a high priority for successful new commercial development on a large scale in northern Alberta. Similar considerations apply to reconstituted products, such as laminated veneer lumber (LVL).

Specialty lumber options, based on aspen, have better potential. These comprise a wide range of products, such as turnings, panelling, shelving, furniture components, bedframes, mouldings and chopstick blanks. The technology to extract the necessary grades and sizes from aspen is readily available. Production economics frequently are variable and the most successful manufacturing operations (such as those in Ontario and the U.S. Lake States) emphasize the higher value-added products. Nevertheless, it should be recognized, in northern Alberta's case, that market for pulpable residuals will be critical. Much additional work is required before specific opportunities can be identified, but an encouraging development is the recent initiative by Canadian Forest Products Ltd. in Grande Prairie to develop market opportunities in aspen lumber specialty products in northern Alberta.

Smaller Scale Wood Product Development Options Could be Considered

It has already been pointed out that there does not appear to be any significant potential for new capacity to produce low value lumber for industrial handling. Higher value specialty products have better potential but are only economic if very high quality logs are used. Such logs are available on some sites but only on a selective basis. Furthermore they are often difficult to identify until the tree has been felled.

It is possible, therefore, that a number of small operators could exist if they were allowed to log on a very selective basis. From the resource management point-of-view this could, however, present some problems. Apart from provincial forestry policy considerations, there could be difficulties. Where the trees are within areas that have already been allocated (this would apply to much of the sites that are more easily accessed), the company with the existing allocation obviously is likely to resist losing the best trees. Even where the resource has yet to be allocated the existence of several small independents removing the best aspen could prove a negative factor to a potential larger investor.

It may be, however, that these difficulties can be overcome. The number of small operators can be limited and their volumes and areas of operation controlled so that any impact on large scale opportunities is minimized. Also it is worth noting that the large complexes such as pulp mills, or waferboard plants, are much more tolerant of variations in raw material quality than a small specialty lumber facility although there is still a cost involved. Thus while a pulp mill can, if necessary, use a great proportion of the qualities and sizes produced during logging, a specialty lumber operation, producing a high value product, can only be economic with the high quality log.

Assuming that the resource allocation aspect can be resolved, there is still likely to be a weakness at the production and marketing level. This type of operation is small and therefore has limited production sophistication and even less marketing expertise. Yet success in the manufacture of specialty products depends on

- consistent volumes and precise specifications
- extensive distribution and marketing since the products are designed for very specific markets.

It would be difficult for an individual small operator to satisfy these requirements alone, and the key to development appears to be in a cooperative marketing and distribution arrangement, perhaps assisted through regional development funding.

Despite Considerable Potential, A Number of Serious Constraints to Development Exist

One of the keys to successful economic expansion of the unutilized portions of the forest resources of northern Alberta is the development of an adequate transportation infrastructure. In many respects, however, this is a "chicken-and-egg" situation. On one hand, development of the full potential cannot be achieved without a) adequate physical infrastructure and b) the availability of rail/truck service offering a competitive rate structure for shipment of product. On the other hand, the economic provision of the physical infrastructure, beyond that which exists today, and the development of a competitive rate structure (e.g. rail) depends on the existence, or potential development, of a viable industrial base.

This study has indicated a reasonably favourable aspen resource situation in, for example, the Fort Vermilion area, yet the nearest rail point is at High Level. There are many similar examples. It is not possible, because of the general nature of this study, to conclude that the absence of an adequate physical infrastructure is the major factor precluding an industrial development. This would require site-specific study. Nevertheless, a basic principle can be identified. This is that for industrial development to proceed in these circumstances, realistically there must be public sector participation in the costs involved.

The detailed analysis of transportation rates, again, is beyond the scope of this study. In some areas there is a choice of transportation modes, but no choice in others. De-regulation of rail transportation in the U.S. is having a dramatic impact upon freight rates and service in North America and, in almost all cases, rates are now directly negotiated between carrier and shipper.

Transportation distances, road haulage weight allowances and transportation cost have been cited in some cases as negative factors affecting the viability of potential forest industry investments in northern Alberta. Any of these may be valid claims. It simply is not possible, in a study such as this, to identify any broad transportation-related constraints which may be precluding new forest product manufacturing investment in the area.

There are other serious and diverse constraints to development. First among these is the issue of business climate. A good business climate is conducive to new investment: a poor one obviously is not. There are two aspects of business climate. The first aspect is the existing image of an area such as northern Alberta (and more generally of Alberta and, in turn, Canada) for forest products investment. The second aspect is related to information. It involves the identification of specific investment potential and it's active promotion through business development.

Business climate is an intangible but very important factor in determining the attractiveness of an area for new capital investment. It is a particularly strong factor where investment is being considered by companies based outside Alberta, on either a direct or joint-venture basis.

Fewer Studies Are Needed: and More Promotion is Required

Alberta scores very well in producing information and studies related to aspen potential. The evidence for this is the extensive number of literature citations contained in the appendices to this study. Alberta scores less favourably, however, in the identification and active promotion of specific investment options.

It should be recognized that in the past few years, many competing supply areas to northern Alberta have taken some unprecedented steps to attract new investments into their areas and to encourage existing industry to expand in higher value-added products. These steps include a wide range of incentives ranging from information packages for specific sectors (e.g. quantifying favourable investment conditions) to comprehensive financial and taxation treatment. Examples include some U.S. states and many overseas countries.

In the pulp and paper industry specifically, there has been a major and positive shift in the attitude of local and state/provincial governments to this sector compared with a decade ago. In the buoyant demand conditions of the early 1970's, when very favourable growth rates were anticipated to continue for a wide range of products, it was comparatively easy to attract new investment. Today, the situation has been reversed. Companies seeking expansion are faced with tough competitive conditions. They are selective in their investments and they are attracted to those areas which offer the greatest potential for success and which minimize the business risks inherent in new ventures.

Areas which offer the best investment climate usually are the first to attract new investment. Canada's recent history has not been good in this respect and, compared with earlier decades, only a limited amount of new investment has taken place in the forest products industry over the past ten years. It appears probable, that unless this changes, much of the potential for forest products production in northern Alberta may not be realized.

For Some Product Opportunities, The Lack of External Economies is a Constraint

Any region which has an established industrial structure in a particular technology, normally offers certain advantages to complementary industries commencing operations in the area. These external economies include an established labour force in the technology in question; management skills and various other factors such as an established infrastructure (e.g. suitable rail stock for shipping comparatively high valued papers); an established distribution network and so on. In this regard, regions such as British Columbia have external economies in bleached softwood kraft and newsprint. The U.S. Midwest has external economies in LWC papers and the U.S. Northeast (non-integrated) and U.S. South (integrated) in u/c woodfree papers. The existence of these factors enhances the relative attractiveness of one region over another for new related investment.

Northern Alberta's external economies in forest products are limited. At present they include items such as softwood lumber, waferboard and market pulp. For some of the new product opportunities identified in this study, the limited external economies which exist in northern Alberta are not necessarily an unsolvable problem providing that at least some of these factors (e.g. key trained operating personnel and management) can be brought into the region by an established producer of such grades from another region, or where such skills can be obtained through joint-venture, or affiliate, arrangements involving the producer and paper maker/paper user.

In another respect, however, northern Alberta does have reasonably good future prospects as far as development of its existing product base and related new products (e.g. market pulp) are concerned. The region already has a well established lumber, waferboard and bleached kraft pulp industry and most of the highly rated forest product development options identified in this study capitalize on these existing strengths.

An Aggressive Approach to Development Promotion is Necessary...

It is recommended that the NADC should direct its future policies for forest products development towards the active promotion of the aspen-based products short-listed earlier in this Executive Summary. These are the ones which will optimize northern Alberta's comparative strengths (competitive wood costs, its fibre resource quality and Alberta's plentiful supplies of low cost energy, compared with areas such as the U.S.).

...But Only After Development Strategies Have Been Carefully Considered

It is essential that before active promotion is undertaken, the NADC should coordinate this process with initiatives being undertaken by provincial government departments. Specifically, possible locations for an LWC plant (one of the options available to northern Alberta) have been discussed also in southern Alberta. Clearly, uncoordinated active promotion of the same development option, in say the U.S., by two or more organizations from Alberta would have an adverse impact on Alberta's chances of success.

Once Decided, These Strategies Should be Pursued Consistently

Experience in areas seeking development in forest products has shown that success normally is greatest where a) viable development options have been correctly identified before development initiatives have been undertaken and b) where the development authority has not tried to be "all things to all men." It is the responsibility of the NADC to satisfy itself that a) has been adequately researched. Subsequently, with respect to b), it will be **imperative to be consistent** in promoting the product options in which northern Alberta will be claiming it can offer very competitive and attractive investment conditions.

Even So, Development Will Be Gradual

Even under optimum business climate conditions in northern Alberta, it should be recognized that future expansion of the forest products industry in northern Alberta would be gradual. A few of the product options appear to have immediate investment potential, as discussed earlier, and the employment and income implications could be significant. Most others are medium to longer term. Clearly, it is possible, through special measures and incentive programs, to bring forward some of these medium and longer term options, as discussed earlier.

Three broad criteria have been used to evaluate potential development options (i.e. technical feasibility; economic feasibility and market outlook). In product options identified, northern Alberta varies in its ability to compete with other areas on each criterion. Moreover, many product options have been researched only at a general level and more specific targetting of future study work is required.

For general planning purposes, however, the very approximate timing of aspen-related forest products development in northern Alberta, under current assumptions, can be summarized as follows:

APPROX. TIMING OF FOREST PRODUCT DEVELOPMENT OPTIONS FOR NORTHERN ALBERTA

Period	Investment Options which Could Prove Viable
1985-1990	Aspen/Spruce Bleached CTMP
"	Light Weight Coated (LWC) Paper
"	Specialty Lumber Operations
1990-2000	Aspen Bleached Kraft Market Pulp
"	Uncoated Groundwood Papers
"	Waferboard/OSB
Beyond the year 2000	All Other Short-listed Investment Options

Some Immediate Initiatives Should Be Considered

In order to facilitate the early development of the highly ranked forest product options in northern Alberta, three specific initiatives should be considered. These are:

1. Aspen Harvesting Policy

The government of Alberta has developed a flexible and negotiable approach to forestry development. Whilst tHE maintenance of this flexibility is desirable, some clarification of harvesting policy and resource availability is necessary in order that viable development options can be correctly identified.

Hardwood AAC's should be recalculated at the earliest opportunity, taking into account age class distribution, decay-age trends, and softwood harvest schedules. This should facilitate realistic identification of areas with potential for viable economic development.

In areas defined as having good potential, more detailed clarification of policy is necessary as a prerequisite to the promotion of targeted product-market opportunities. The availability of these forest lands for both long term and short term hardwood utilization should be clarified in relation to alternative uses such as softwood production and agriculture. In recognition of the fact that only a proportion of existing stocks are likely to be successfully utilized, it will be necessary to realistically define (in terms of accessibility and quality):

1. what components of the resource operators will be obliged to utilize,
2. what components will be recognized as unusable,
3. what obligations the public and private sectors have to rehabilitate unusable stands, and
4. how local discontinuities in supply (resulting from age class imbalances) may be accommodated.

2. Promotional Package

It is recommended that, when its development strategies have been determined, the NADC (in co-ordination with the provincial and the federal government) should consider the preparation of a promotional package specifically for forest industry development (involving available softwood and hardwood resources) targetted to specific product-market opportunities.

Various examples of successful promotional packages prepared for areas outside Alberta have been discussed with the NADC and the Steering Committee. They are principally designed to inform potential investors. The issue of the possible need for industrial incentives has been raised by the Committee. This issue is outside the scope of this report. Such incentives may be found to be necessary, but it is suggested that a) the need and b) the extent of any incentives should be determined independently of this report.

3. Active Marketing to Potential Investors

A program of active marketing should be developed, in consultation with, or carried out by, the provincial government. This could arise out of the recently signed Canada-Alberta Forest Resource Development Agreement and should continue over a 4 to 5 year period.

1.0

INTRODUCTION AND TERMS OF REFERENCE

Aspen's Image in Canada

Trembling aspen is the most numerous of the three hardwood species that grow to commercial size in northern Alberta. It has been said that probably more studies have been carried out on potential uses for Canada's aspen resources than on any other major timber species. A significant number of these studies have involved examination of Alberta's aspen reserves, including the extensive, but still underutilized stands in northern Alberta. Based on a review of the literature, it is probably fair to say also that most studies have identified two major issues regarding the Alberta resource. Firstly, that it holds tremendous promise for longer term utilization but, secondly, that there are significant constraints to more extensive commercial utilization than exists at present.

At the outset, it should be stated that there are some very good examples of successful forest product operations in Alberta based on the resource. Moreover, it is true that very real constraints to higher levels of utilization do exist. Nevertheless, with the passage of time, many of the less favourable reviews of market potential carried out some years ago are probably unduly pessimistic in the light of today's conditions.

The terms of reference for this study (see below) request a review of existing literature pertinent to the hardwood resources of northern Alberta. Of necessity, therefore, the reader of this study must be prepared to encounter conclusions regarding development potential which may sometimes appear to be heavily qualified in cautionary notes. At other times conclusions may appear to be pessimistic in tone.

It is suggested that, where this is the case, the reader should bear in mind that the keys to timber utilization, in the forest products industry, are 1) markets and 2) economics. There is a well documented evolution in utilization worldwide whereby, for sound commercial reasons, preferred species and sizes normally are harvested first. Later, as the supply of these declines and the costs of logging less accessible sites increases, the commercial value of other species is enhanced and higher levels of utilization commence. An exception to this is where technological or market changes shift the balance of desirability in favour of lesser utilized species. This has been the case, for example, with aspen waferboard and oriented strand board (OSB) which are now produced in Alberta and in other areas.

As discussed later in this study, it appears that there are grounds for cautious optimism that much more of northern Alberta's hardwood resources could become economically attractive for forest product investment within the next five to ten years. A number of recent studies have pointed to this possibility.

Purpose of the Study

The study goals, as outlined in the terms of reference, are:

(1) To prepare from recent literature a concise, readable description of the hardwood resource, as well as industry and government research activities to develop it. In particular to summarize the potential opportunities, benefits and problems associated with the development of hardwoods.

(2) To examine the constraints to the development of the resource, including physical, technical and economic considerations. This analysis should lead to a series of recommendations or a potential strategy for the future development of the hardwood resource in northern Alberta.

Background to the Study

There are more than 5 million hectares of pure or predominantly pure poplar stands in northern Alberta forests. Only a small proportion of this vast resource is presently being used. Hardwoods, despite their rapid growth and overall abundance, suffer from competitive disadvantages relative to Alberta softwoods and hardwoods from other regions.

A good deal of work has been done to eliminate these disadvantages. Research into new products and technologies continues. Experiments by the industry have also been carried out. Research into markets and feasibility studies for a variety of uses and products has been undertaken. Some of the initiatives have shown promise, others have not.

If viable economic uses for hardwoods can be found, the resource will be of substantial benefit to northern Alberta.

The Northern Alberta Development Council (NADC) believes that every effort should be made to resolve the outstanding technical and developmental problems. Consequently, the NADC has commissioned this study, undertaken in cooperation with Alberta Energy and Natural Resources and Alberta Economic Development to examine the current "state-of-the-art" of development of hardwoods in northern Alberta. The report is intended also to assist the continuing dialogue between government and industry about how best to overcome the constraints to increased aspen utilization.

Alberta's Fibre Reserves in the Global Context[1]

In the past decade, there has been a great deal of discussion about the prospect of global deficits in economically accessible supplies of softwood and hardwood timber. This has caused concern in some major traditional supplying areas, such as Canada, where it was assumed that the softwood timber reserve was much greater. The other side of the picture, however, has been an increased level of interest in fibre supply potential from (a) "new" supplying areas (particularly in plantation developments, e.g. Brazil, South Africa, Chile, etc.) and (b) areas of timber previously considered to be marginal by virtue of location, stand-densities, species, timber quality and so on.

In the late 1970's, many companies were still actively searching for uncommitted supplies of timber - particularly softwoods. Alberta's comparatively large uncommitted reserves (hardwood roundwood, softwood residuals and softwood pulpwood) were the subject of considerable interest and a number of important initiatives to develop the resource were undertaken by the province. The recent severe economic recession has had two principal impacts of the development of this resource from a demand point of view. Firstly, many already established producers previously considering expansion are finding that they have sufficient existing commitments for their (now modified) future needs. Secondly, the near-term outlook for growth in product demand and real prices has dampened enthusiasm for at least some major new capital investment projects forcing companies worldwide to closely examine their longer term competitive positions.

In the late 1970's, Alberta certainly justified a position on most companies' "shopping-lists" as an area for expansion in Canada. Given the recent recession, however, the immediate outlook for many companies is for priorities to be placed on upgrading of existing facilities in currently committed areas.

The analysis presented in this study indicates that Alberta still can offer competitive strengths in a number of important aspects. The reality is that the comparative attractiveness of these factors has to be viewed in the context of a much more competitive climate for new investment. Development of these resources is not so much a question of "if" as "when".

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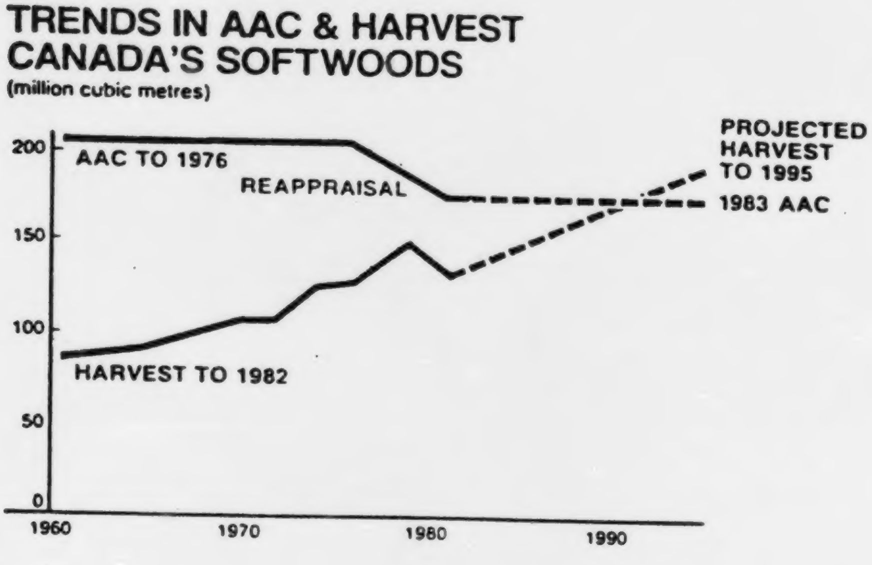
[1] Source: Woodbridge, Reed and Associates Ltd. 'Development Opportunities for Paper Manufacturing Operations in Alberta' (1984).

Canada's Fibre Supply Outlook

Figure 1-1



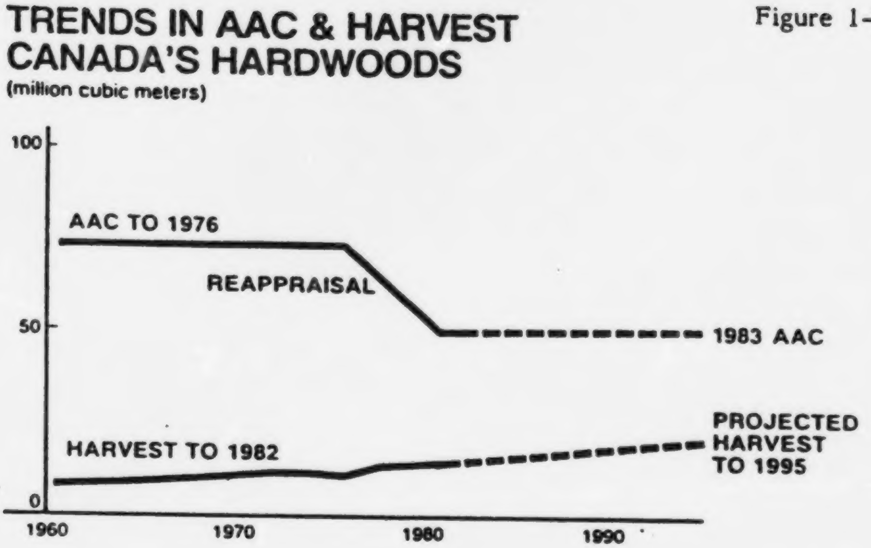
Source: Canadian Pulp and Paper Association (CPPA)

Figure 1-1 illustrates the outlook for softwood timber harvesting in Canada compared with 1983 annual allowable cut at present levels of forest management. It is anticipated that, at projected levels of harvesting, Canada's existing economically accessible reserves of softwood will be largely depleted by the end of the current decade or the early 1990's. It should be noted that the reserves refer to both committed and uncommitted volumes.

The outlook for increased harvest levels in hardwoods (Figure 1-2) is more encouraging - particularly when trends in papermaking (using more short-fibred pulps) and Alberta's significant reserves of aspen (a low density species for pulping) are taken into account.

Table 1 quantifies the most recently available estimates of incremental fibre supplies in Canada. Significantly, Alberta's estimated 17 million cubic metre reserve represents the largest incremental wood supply in all of Canada.

Figure 1-2



Source: CPPA.

Table 1

Canada's Incremental Fibre Supply
(volume in million m^3 per year)

	Softwood		Hardwood		Total	
	Volume	**%**	**Volume**	**%**	**Volume**	**%**
British Columbia	1.83	8.7	2.25	6.5	4.08	7.3
Alberta	5.71	27.1	11.27	32.4	16.98	30.4
Sask. and Man.	2.86	13.5	4.35	12.5	7.21	12.9
Ontario	5.79	27.4	4.93	14.2	10.72	19.2
Quebec	4.91	23.3	11.04	31.8	15.95	28.6
Atlantic Prov.	-	-	0.90	2.6	0.90	1.6
Total	**21.10**	**100.0**	**34.74**	**100.0**	**55.84**	**100.0**

Source: Woodbridge, Reed and Associates Ltd.

Moreover, in hardwood species, Alberta accounts for almost one-third of Canada's incrementally available annual supply. Alberta's incremental hardwood supply is estimated at around 11.3 million m^3/year. As noted in subsequent sections, northern Alberta in turn accounts for a sizeable proportion of this supply.

2.0

HARDWOODS IN NORTHERN ALBERTA

The fibre supply aspects of this study are discussed in three parts. Any rational evaluation of a resource requires some understanding of its characteristics. This section summarizes available information on hardwood ecology, management, pathology, growth and yield most relevant to utilization of the species in northern Alberta. Where information is weak or lacking, assumptions we have made later in the study, particularly regarding decay levels and stand dynamics, are explained.

Sections 3.0 and 4.0 provide a more quantitative evaluation of hardwood supply potential. The situation regarding current annual allowable cuts (harvest levels permitted on a management unit basis by the Ministry of Energy and Natural Resources) is described, together with associated commitments and estimates of relative delivery costs. Inventory statistics and projections of possible harvest levels under a number of management and utilization alternatives are presented. They are based on new inventory data which will replace that used for the current allowable cut estimates. The implication of these projections to harvest policy and operations is discussed.

The Hardwood Species in Northern Alberta

Ecology and Management

Three species of hardwood grow to commercial size in northern Alberta: trembling aspen (Populus tremuloides Michx.), balsam poplar (Populus balsamifera L.) and white birch (Betula papyrifera Marsh.).

Trembling aspen is the most numerous of the three in Alberta. In fact, it is the most widely distributed tree species in North America. Its range extends from Newfoundland west across Canada into northwestern Alaska. It grows as far south as New Jersey and Iowa, with outliers in Virginia and Missouri. It also occurs throughout the mountains of the western United States and into northern Mexico. When reviewing utilization of aspen in northern Alberta, we must remember that essentially the same resource occurs in many locations closer to most major North American population centres.

The extensive occurrence of aspen is in large part a result of its successful ability to regenerate through root suckering (Barnes 1966). This allows re-establishment after fire, logging, insects or disease have caused death of the overstory, as long as the root system has not been killed. Suckering is from lateral roots located some distance below the surface of the soil (Schier 1973a). While the tree stems are alive, the leaves and buds exert hormonal control which prevents suckering (Schier 1973b, 1976). Any disturbance which upsets this control will result in sucker production (Schier 1981). Death of the stem allows the soil to warm, which also stimulates suckering (Schier 1976, Steneker 1974, Maini and Horton 1966). Thus, the species is well adapted to frequent and devastating disturbances, which are a natural part of northern Alberta's ecology. It is also well adapted to extensive forest management, where the forester wishes to re-establish growth and stocking as quickly and inexpensively as possible after clear-cutting.

In northern Alberta, the characteristic forest association on the moist and better drained sites is the Boreal Mixedwood which is, as the name implies, a mixture of varying proportions of trembling aspen and balsam poplar, birches, white spruce and balsam fir. The cover type of greatest areal extent within the association is trembling aspen, a result of this species' above-mentioned ability to regenerate readily following disturbance (Rowe 1972). There is a marked successional trend for the white spruce to replace aspen and poplar in the older forests, but this trend has been checked by frequent fires which encourage aspen by wiping out the spruce and fir and allowing reproduction by suckers from surviving aspen roots. If not checked by fire, white spruce and balsam fir will eventually overtop aspen (Dix and Swan 1971).

In parts of the region the Boreal Mixedwood gives way to the Lower Foothills section (this includes areas such as the Caribou Hills and Pelican Mountains as well as the Rocky Mountain foothills themselves). Here aspen is again important as a successional species, often in association with lodgepole pine (Rowe 1972).

Many individual stems may result from production of suckers by a single root system of aspen. This is a characteristic significant to its management and utilization. All of the resulting stems are genetically identical and form clones (Barnes 1966). Although aspen produces very viable seed from an early age, the seed is small and viability is retained on the forest floor for only about three weeks, so site conditions must be excellent for seedlings to become established. Consequently, seedling establishment is rare (Brinkman and Roe 1975), and most of the aspen we see in northern Alberta are clonal in origin. Many clones have probably been extant here since withdrawal of the Pleistocene ice sheets.

Aspen grows on a variety of soil types, but throughout its range best growth occurs on porous, loamy soils. Growth is generally poor on heavy clay due to lack of aeration, and on sandy soils with excessive drainage (Fowells 1965).

Balsam poplar, like aspen, is an early successional species with striking capabilities to reproduce naturally through root suckers or stump sprouts after disturbance. While the species is common, it is much less abundant than aspen. It typically occupies moist sites along river flats, alluvial bottoms and the borders of bogs, but is generally considered similar to aspen in its site requirements. It is often found intimately mixed with aspen, a situation which is problematic for existing panelboard operations in Alberta which currently utilize only aspen.

White birch is the least abundant of the three hardwood species. When killed by fire, it can reproduce itself quickly by developing sprouts around the base of the trunk, but does not spread by vegetative propagation to the same extent that does aspen. Being intolerant of shade, it thrives on burned-over and cut-over areas, where it can form pure stands. However, it becomes restricted to openings when other tree species establish themselves and the forest matures.

Because of the similarities in ecological characteristics and requirements of balsam poplar and trembling aspen, and the relatively minor extent and significance of white birch, the three species will not be differentiated in the following comments on management practices applicable in Alberta.

Clearcutting is normally used in harvesting. Because it removes the hormonal suppression on suckering, it lends itself well to the capabilities of the species for rapid vegetative regeneration (Bella and De Franceschi 1972, Ohmann et al 1978). Much research has been done on silvicultural techniques for promoting suckering after harvesting (Perala 1972, 1977, 1978, De Byle 1976), control of initial stand densities (Kozlowski and Keller 1966, Schier and Zasada 1973, Bella and De Franceschi 1972, Schier and Campbell 1978), control of competing vegetation (De Byle 1976, Perala 1972, 1974), and thinning (Perala 1972, Steneker 1974, Bella 1975). However, it appears that under most conditions, providing the stand is clearcut before it becomes excessively overmature, more than adequate natural regeneration will occur without additional intervention. Furthermore, if the regeneration is too dense, the stand thins itself naturally with little loss of growth due to competition (De Byle 1976, Sorensen 1968). Artificial thinning (the felling of a proportion of the trees in a stand) can increase production on retained sawlog and veneer-quality trees, but with questionable economic return under western conditions and it may increase disease and insect damage (Perala 1972).

Although healthy aspen stands, when clearcut, usually regenerate themselves well without further investment by the forest manager, the same cannot be said for stands which have become overmature or decadent. Decadent stands have typically escaped fire or clearcutting for lengthy periods (Graham et all 1963, Fralish 1972, Schier 1975), and have deteriorated to a state where sucker production is insufficient to replace trees that are cut or die naturally. Re-vitalization, replacement or conversion of such stands may be very slow under natural conditions. Felling, herbicide treatments, prescribed burning and other silvicultural techniques can be used to accelerate the process, but require investment (Olson and Lundgren 1978). Such investment may well be unattractive, especially since the standing timber by this stage has little or no commercial value. Thus in northern Alberta we are faced with the irony that if we protect our aspen resource from fire but do not harvest it, its potential utility will ultimately decrease, with the accumulation of decadent stands which are expensive or slow to be put back into production.

Defect

Trembling aspen and balsam poplar are subject to a number of decay diseases which cause timber loss and degradation of wood quality. In the past, defect resulting from decay has been a major factor in limiting the successful utilization of aspen in Alberta (Rytz 1980) and will likely continue to be so in the future (Fregren 1980). Thus, decay is of paramount importance in any consideration of hardwood utilization in northern Alberta.

The most frequently reported decay organism in northern Alberta is **Fomes igniarius**, often referred to as white heart rot or white trunk rot. It is more prevalent in aspen than in balsam poplar (Fowells 1965, Moss 1932). The rot enters the trunk of the tree through wounds such as where branches have broken off or where frost cracks have opened the bark (Etheridge 1961, Zalasky 1976). Infection goes through several stages including stain (where the wood is discoloured but the structural integrity is maintained), through incipient or intermediate decay (when the cell walls making up the wood are beginning to break down), to advanced decay (when the wood is soft and visibly decomposed). Many other organisms are involved in the decay of hardwoods, including bacteria, butt and root-rotting fungi and trunk and butt infections of unknown cause; but **Fomes** is generally recognized as the most important (Thomas, Etheridge and Paul 1960, Hinds 1976, Schipper and Anderson 1978).

Although the significance of decay to commercial development of the resource is accepted, our ability to predict the extent of decay in existing or future hardwood stands is poor.

Most surveys of forest resources, including the Alberta Phase III Forest Inventory which provides the quantitative basis for this study, depend on aerial photography and photo-interpretation, with limited ground sampling to acquire external measurements, such as height and diameter, of standing trees. Only a very tiny proportion of the trees are felled so that internal measurements of decay can be made. Consequently, foresters usually rely on the relationship of stand conditions and external tree "indicators" to decay in assessing the quantity of defect in a forest inventory.

The inability to accurately predict defect in aspen results mainly from the large amount of variation in decay which we cannot explain in terms of easily-measured conditions or indicators. It is known or suspected that decay is influenced by tree growth (e.g. Paul and Etheridge 1958), site quality (e.g. Hinds 1976), genetic constitution of the tree or clone (e.g. Wall 1971), natural and man-caused injury (e.g. Zalasky 1976), forest cover type, stand disturbance and stand density (e.g. Prince Albert Pulpwood 1983) and age of the tree or stand (e.g. Kirby et all 1957). Unfortunately, these influences and their interactions are complex and poorly understood. The situation has been aggravated by inconsistencies in the definition of stain, incipient and advanced decay, and in the selection of samples and assessment standards (Hiratsuka and Loman 1984). Key stand conditions, such as age, are often difficult or expensive to measure and in the past priority has been given to acquiring measurements of the commercial coniferous trees, rather than the hardwoods.

In this study, in spite of the above-mentioned difficulties, we attempted to relate the percentage of decayed wood to stand age. Since estimates of stand age are available for northern Alberta from the Phase III Inventory, we reasoned that the extent of decay could then be related to the inventory statistics and projected into the future. Relating decay to other site variables was considered futile at this time, either because research had failed to quantify the relationship or because the inventory data did not include the potential indicator variables.

Many reports suggest that the incidence and volume of decay in aspen and balsam poplar are most strongly related to age (Meinecke 1929, Riley 1952, Black and Kristapovich 1954, Kirby et al 1957, Basham 1958, Paul and Etheridge 1958, Thomas et al 1960, Bailey and Dobie 1977, Hinds and Wengert 1977). This is not always the case (e.g. Pedology Consultants 1982). Unpublished analyses by the Alberta Forest Service (AFS) of hardwood trees felled, sectioned and scaled as part of the Phase III Inventory program did not indicate any clear trends between decay and age. However, informal studies and observations by field staff of the AFS suggest a rapid loss in volume after ages of 100 to 110 years, with little or no merchantable volume left by 140 to 160 years.

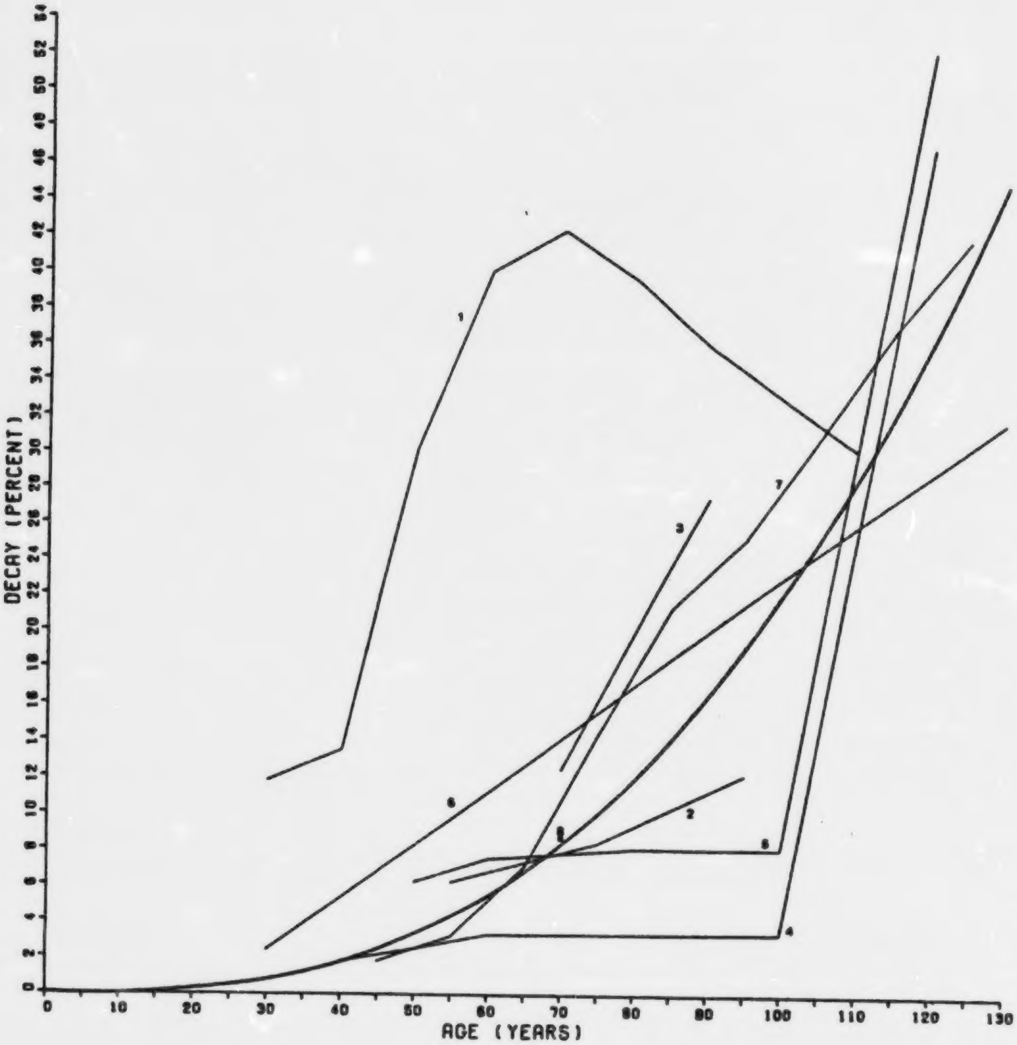
Figure 2-1 illustrates some of the reported trends between percentage decay and tree or stand age in aspen. Note that estimates often conflict, even between reports for the same geographic area.

Cull percentages quoted by operators and foresters experienced in logging and scaling aspen are also of interest. ("Cull" is the component of roundwood volume rejected, owing to decay or other defect, when trees are measured according to accepted scaling rules and standards, after they have been felled and bucked into logs.) Locally accepted cull percentages for aspen in the Slave Lake area, gleaned by the AFS from experienced operators, are 10 to 15 per cent for the 60 to 80 year age class and 25 to 30 per cent for 80 to 100 years (McDonald 1980). During the 1983-84 operating year the average cull reported by the AFS for aspen delivered to the Weldwood plant near Slave Lake was 19 per cent. Weldwood staff noted that current cull levels in wood delivered from the more mature stands (115 to 135 years) are running at about 26 per cent, and that, after pre-selection is taken into account, this probably equates to an average of 30 per cent or more in the standing inventory.

The Edson area is generally considered to contain aspen of better quality than is normal for northern Alberta. Forestry staff at the Pelican OSB plant noted that cull percentages in harvested stands did not normally exceed 8-10 per cent. Percentage cull in wood delivered to the plant has so far been very low (3 to 4 per cent in 1983/84 according to the AFS). Again, this is somewhat less than the level in the standing inventory, owing to pre-selection (whereby high defect trees and areas are avoided, and logs with more than 50 per cent cull can be left in the woods). Stands harvested by Pelican are in the 85 year age range and so far do not exceed 110 years.

Figure 2-1

Reported Trends in the Decay of Aspen with Age



References:
1. Paul and Etheridge (1958) Slave Lake, 2. Bailey and Dobie (1977) Slave Lake, 3. McDonald (1980) Slave Lake, 4. AFS Forest Measurement Section (unpublished) Pulp Cull, 5. AFS Forest Measurement Section (unpublished) Sawlog Cull, 6. Kirby, et al. (1957) Saskatchewan, 7. Black and Kristopovich (1954) Sask. and Manitoba, 8. Pedology Consultants (1982) Central Alberta.

In the Grande Prairie area Procter and Gamble report low levels of cull for aspen stands considered suitable for pulp production. These stands are under 70 years of age and generally closer to the mill than the more valuable coniferous resource.

In order to construct a simple mathematical model which could be used in this study for predicting decay levels in forest inventory projections, various formulae were manipulated until curves were obtained which seemed to best represent the relationship between decay and age. Given the amount of variation observed in the literature and in production experience, the selection of such curves was necessarily subjective and the resulting predictions will obviously deviate widely from the actual cull percentages encountered in many specific situations. Figure 2-2 summarizes these predictions (formulae and tables are presented in Appendix A2). Note the exponential increase in decay forecast for aspen. The stand is considered effectively "broken-up" and unusable by 140 years of age, when the decay percentage exceeds 50 per cent.

Decay is defined here to include intermediate as well as advanced stages, in which discolouration of the wood is accompanied by some degree of decomposition and loss of strength. The sum of advanced and incipient decay is considered analagous to the "internal pulp cull" category recognized by the AFS (Pedology Consultants 1982).

It has been informally observed that hardwoods in mixed hardwood-softwood stands in Alberta are more durable (i.e. show less defect at a given age) than those in pure stands. An apparently opposite effect is reported in Saskatchewan (Prince Albert Pulpwood 1983). In Alberta, the Phase III inventory classifies age in mixedwood stands according to the softwood component. We have assumed for the purposes of this study the same relationship between decay and stand age in both hardwood and mixed types, bearing in mind that the hardwoods in mixed types will usually be older than the inventoried stand age.

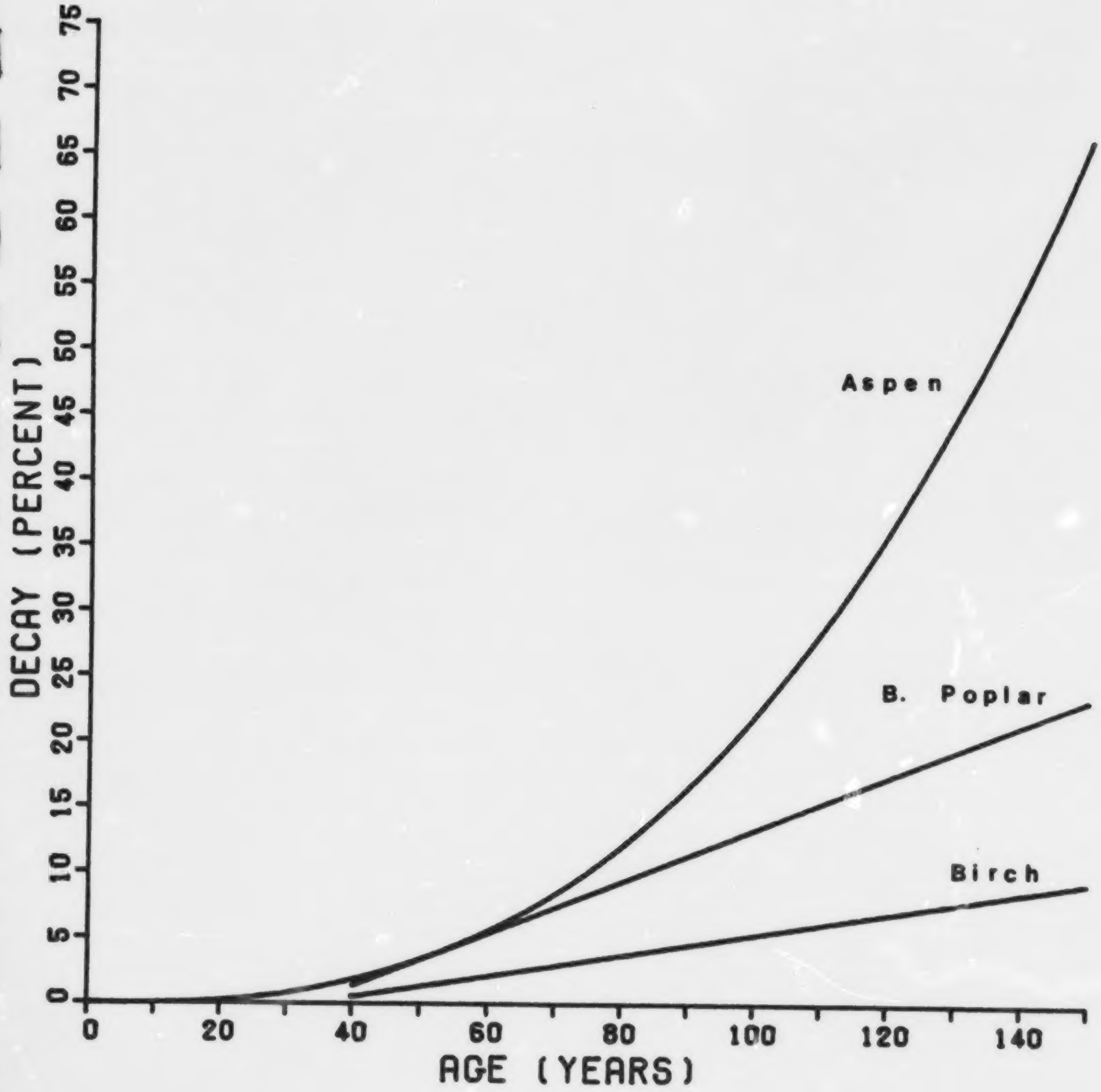
Stain or discolouration are not usually considered as defect or cull unless accompanied by perceptible structural weakness. There is little work available to predict amounts of stain in hardwoods. Stain, as distinct from decay, is more prevalent in balsam poplar than in aspen (Thomas et al 1960). Pedology Consultants (1982) reported 40 per cent stain in balsam poplar (as a percentage of total merchantable volume including decay) as compared to 19 per cent in aspen.

Growth and Yield

Some understanding of the growth of hardwood stands and the useable volumes they might produce at a given age, is fundamental to any evaluation of the resource and to the meaningful planning of its utilization.

Figure 2-2

Percentage of Decayed Volume Predicted in Relation to Age for Aspen, Balsam Poplar and Birch



Hardwood forests are slow producers relative to agricultural crops, but nevertheless they are a dynamic renewable resource. This means that they have the capability for growth and renewal, but it also means that time is an important factor in their exploitation. To be successfully utilized, they must be harvested after the trees are large enough for manufacture, but before they succumb to disease and mortality.

A few studies of aspen growth and yield in the prairie provinces have been undertaken (Kirby et al 1957, Johnson 1957, Bella and De Franceschi 1980, Grabowski 1981). Yield tables have been published for mixed softwood-hardwood stands, but these have placed most emphasis on the coniferous species (MacLeod and Blyth 1955, Johnstone 1976). None of the above studies can readily be applied to projecting future yields from provincial forest inventory data.

Published information on rotations applicable to hardwoods in northern Alberta is sparse and not very enlightening. (A rotation is the length of time required between successive harvests and is usually an important consideration in deciding how fast existing stands can be liquidated and how much wood can be cut from a particular area.) Steneker (1976) suggested rotations between 30 and 50 years for aspen stands in the prairie provinces. However, his recommendations applied to tended stands and appear to relate more to experience in the Lake States, as reported by Brinkam and Roe (1975), than to conditions in northern Alberta. Kirby et al (1957), referring to unmanaged stands in Saskatchewan, state that "there can be little doubt that 70 years is the approximate rotation age for the maximum fibre yield of aspen stands". Bella and De Franceschi (1980) calculated an optimum rotation for biomass production of 30 years (biomass is the weight of the whole tree, not just the merchantable stem), but biomass utilization has not yet been adopted as a basis for forest management in Alberta.

To demonstrate trends in hardwood growth and yield in northern Alberta, we have drawn on our own experience, including a detailed analysis of tree and sample-plot data undertaken for the AFS (Dempster et al 1983). Assumptions regarding decay, discussed previously, as incorporated. Figure 2-3 indicates trends in volume yield which might be expected from a well-stocked natural stand of aspen growing under average site conditions in northern Alberta. Note that yield depends on the utilization standard assumed. Five metric standards, based on minimum stump and top diameter specifications, are illustrated (these are more precisely defined in Appendix A3). Total stem volumes (0/0) are not currently utilized in Alberta. The small roundwood (13/7) standard is considered appropriate for coniferous pulpwood. Because heavy branching tends to prevent utilization of hardwoods to a small top diameter, it may not necessarily be applicable to aspen utilization. The large roundwood (15/10) standard is being used by the AFS as a basis for the determination of annual allowable cuts. It equates to the "6 and 4" utilization policy (whereby trees of greater than a 6-inch stump diameter are utilized to a 4-inch top diameter) which holders of coniferous quotas are being encouraged to adopt in the future. The small sawlog standard (20/13) is currently widely used in Alberta for coniferous sawlog operations and is used for hardwood waferboard operations in the Slave Lake area.

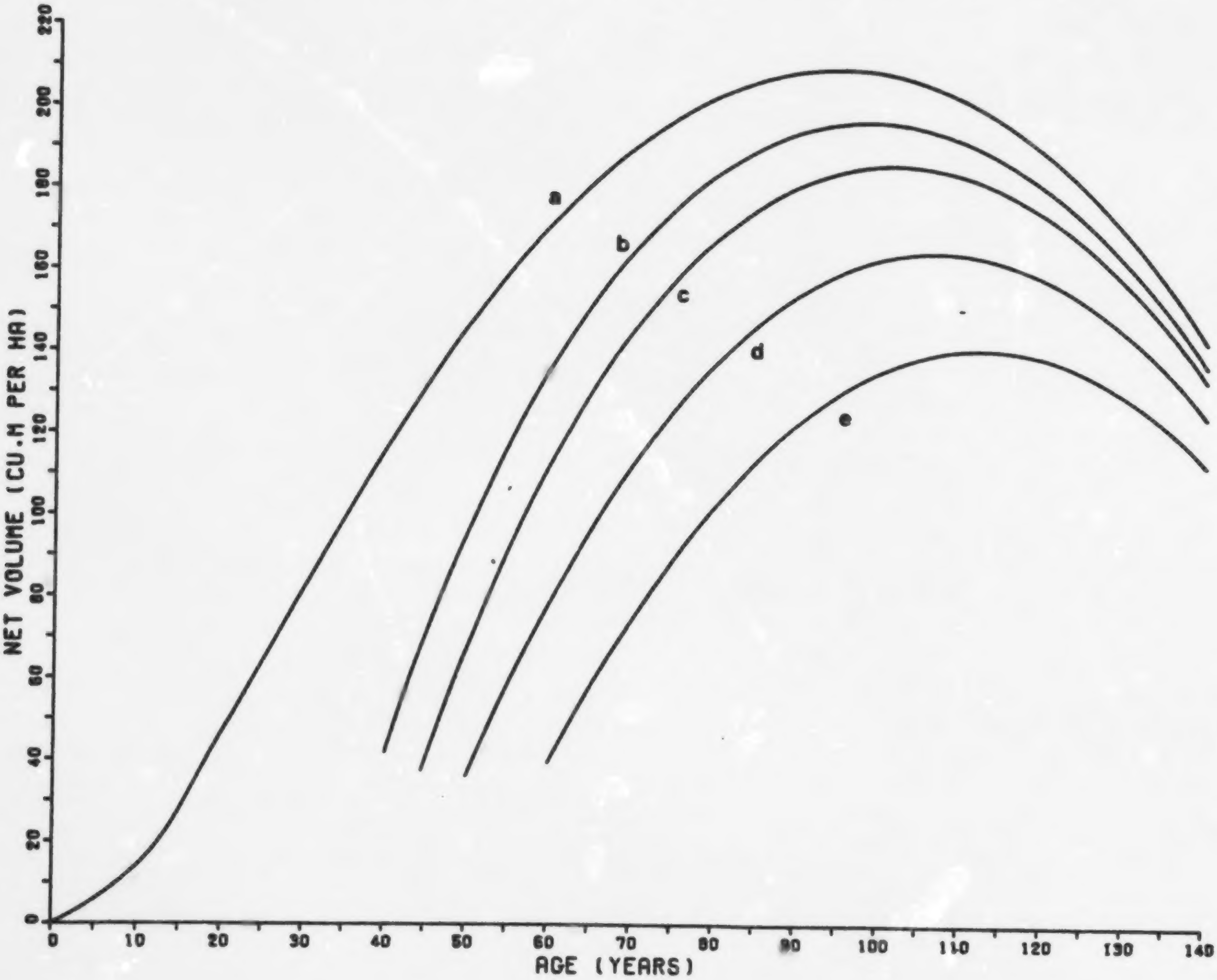


Figure 2-3

Trends of Volume Yields with Age in Well-Stocked Aspen Stands Growing under Average Site Conditions in Northern Alberta

References:
Volumes are indicated for five tree utilization standards recognized by the Alberta Forest Service: a = total stem, b = small roundwood, c = large roundwood, d = small sawlog, e = large sawlog

Estimates at the large sawlog standard (25/15) are indicative of volumes occurring in the larger trees favoured (if defect permits) for lumber and plywood manufacture.

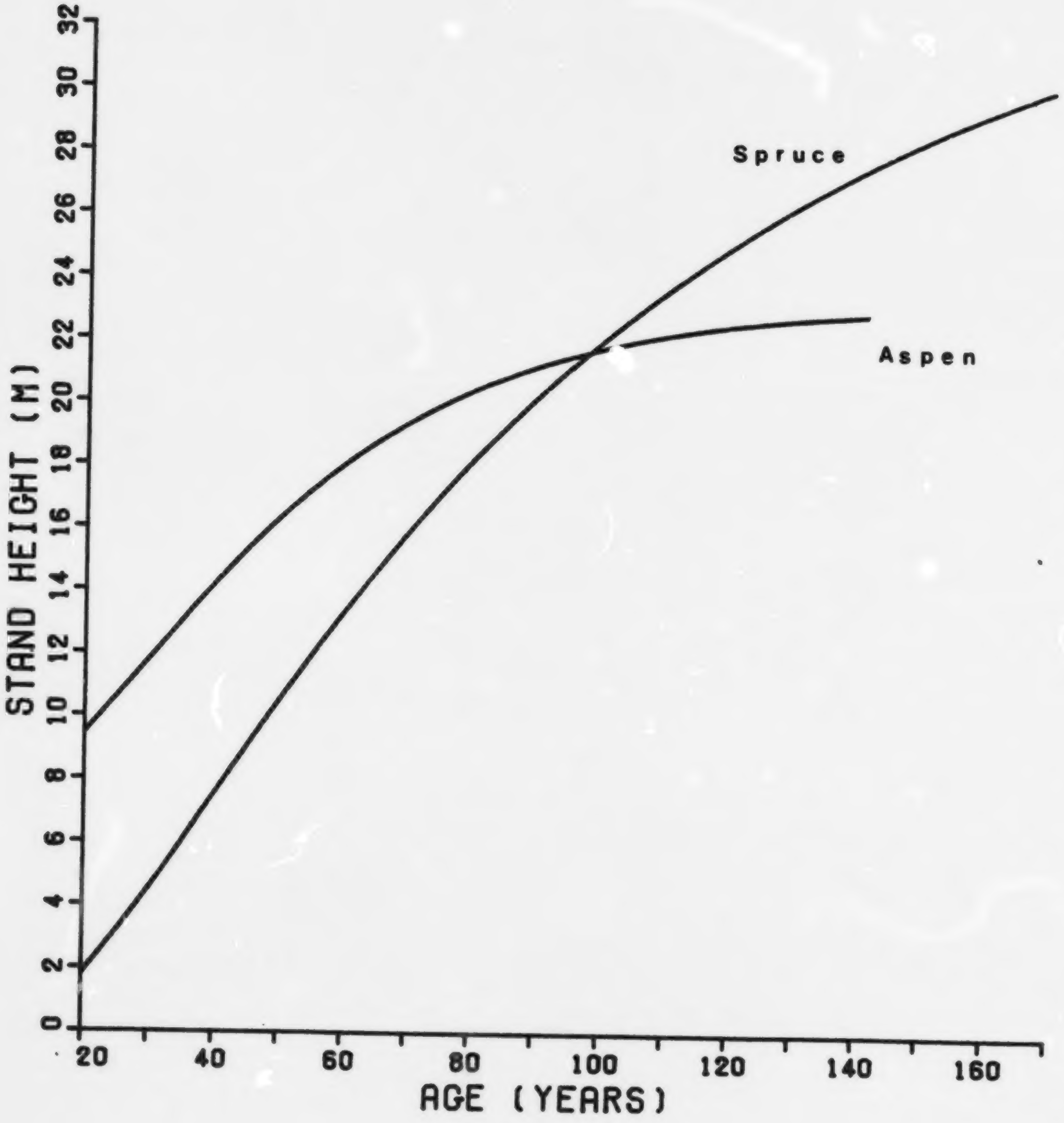
The following trends are noted (see Appendix A3 for tabulated data):

> The stand achieves the minimum volume to be considered merchantable (47.5 net m^3 per ha at the 15/10 utilization standard) at about 50 years. At this stage average merchantable tree size is about 0.13 m^3.
>
> The merchantability standard preferred for current board operations in northern Alberta (90 m^3 per ha at 20/13 utilization) is achieved by 70 years.
>
> Culmination of net mean annual increment (at the 15/10 utilization standard) occurs at about 75 years. This would equate to an optimum rotation for maximizing long term site productivity, assuming the stand were not at risk from destruction by fire etc. and that the operator could handle (though not utilize) the 8 to 12 per cent decay level. Risk may reduce optimum rotations significantly (Reed 1983). Note also that utilization to more stringent size specifications also reduces the optimum rotation.
>
> Useable volume reaches a maximum between 90 and 110 years and subsequently declines due to decay. Average tree size at 100 years (15/10 standard) is about 0.44 m^3.
>
> Between 115 and 135 years the stand becomes increasingly unstable and deteriorates rapidly; by 140 years the stand is probably "broken-up".

The above trends apply to stands which are composed purely, or at least predominantly, of aspen. In mixedwood types containing both hardwoods and softwoods, growth and yield are complicated by successional trends and are very variable. Figure 2-4 demonstrates graphically typical height growth of the aspen and white spruce components in a boreal mixedwood situation. Note that initially the aspen overtops the spruce, but that eventually the situation is reversed. The dynamics of this succession are very variable and cross-over may occur earlier, later, or not at all. The hardwood component tends to be somewhat older than the softwood and it generally matures and deteriorates much earlier. Under current AFS policy, mixedwood stands or hardwood stands with promising coniferous understories, are normally retained for harvesting of the softwood component. Rotations may be from 80 to 150 years; optimum rotations for softwoods in northern Alberta probably average about 120 years. Growth of the softwoods may continue for 170 years providing the stand is not subjected to fire, disease, or blowdown. Because we are dealing with a previously unregulated natural forest, age at harvest will often exceed 120 years. Unfortunately, because of the decay and break-up problems already discussed, we can expect to recover the aspen component only if harvesting is undertaken before an age of about 135 years.

Figure 2-4

Typical Height Development of Aspen and White Spruce Growing in a Mixed Stand



CHAPTER SUMMARY

- In this chapter, available information on hardwood forestry, relevant to utilization of the species in northern Alberta, has been reviewed. Where information is weak or lacking, assumptions which we use later in the study have been explained.

- Aspen is the most numerous of all trees in northern Alberta, to a large extent because of its ability to regenerate readily following distrubances like fire.

- Unfortunately, both trembling aspen and the related balsam poplar are subject to a number of decay diseases and stains, which severely degrade wood quality. The most serious of these, the white heart rot of aspen, spreads through the tree, rotting maybe 10 per cent of the timber by the time the tree is 75 years old, 20 per cent by age 95 and ultimately results in "breakup" of the forest stand, usually by the time the trees are 140 years old.

- The decay is unpredictably distributed throughout the tree in such a way that, although only 10 to 20 per cent of the wood might be rotten, loggers and manufacturers experience great difficulty in economically recovering the sound wood.

- This means that many of the aspen trees in northern Alberta are either already too old and decayed to be utilized or are presently too small. Timing is critical in the successful utilization of the species and the logistic difficulties of harvesting the trees when they are large enough for manufacture, but before they succumb to decay, are not easily overcome.

3.0

HARDWOOD SUPPLY POTENTIAL

Allowable Cuts

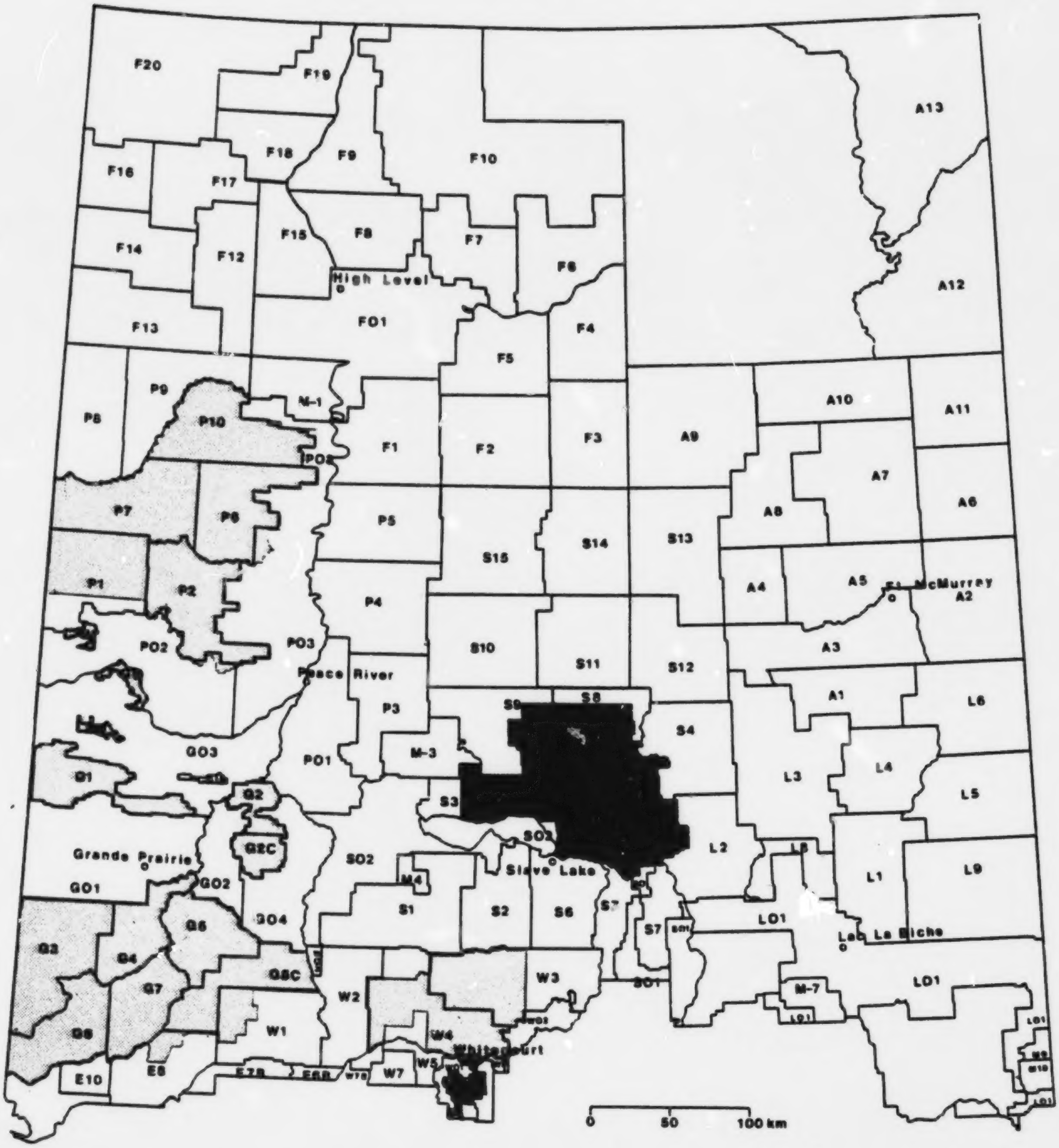
Calculations and Assumptions

The term "annual allowable cut" (AAC), when applied to public lands in Alberta, means the total volume or area of timber that may be harvested in one year, under the authority of The Forest Act, 1971. Under this Act, the Minister of Energy and Natural Resources is authorized to divide public forest lands into forest management units, and to determine the AAC for each unit. The Minister can transfer ownership of Crown timber to the private sector by means of forest management agreements, timber licences (issued pursuant to the sale of timber quotas), or timber permits.

The holder of a forest management agreement is usually responsible for AAC calculation on his area disposition, but this is subject to approval by the Minister and, under the Act, harvest levels must be designed to provide a perpetual sustained yield. AAC's available for harvest under dispositions other than forest management agreements are calculated by the Alberta Forest Service (AFS). Although the Forest Act is not explicit regarding the basis for this calculation, it implies that the Minister should attain "within forest management unit a proper balance between growth and depletion of timber". Indeed, most allowable-cut and forest management planning conducted by the AFS since the inception of the Alberta timber quota system has been on a strict sustained-yield basis, aimed at maintaining potential harvests at the current AAC level for at least the time taken to replace the timber harvested. (A "timber quota" is a share of a management unit's AAC allocated to a particular operator.)

The AAC's for hardwoods referred to in this report are those calculated by the AFS in 1970.

Map 1 shows the forest management units of northern Alberta. The southern limit of the region, defined by municipal boundaries, does not always coincide with management unit boundaries; hence several units fall only partly in northern Alberta. Where this occurs, the AAC of the unit AAC has been prorated according to the proportion of the unit's area falling north of the regional boundary.


F20
F19
F18
F9
F10
A13
F16
F17
F15
F8
F7
F6
F14
F12
High Level
F13
FO1
F4
A12
F5
P9
M-1
P8
P10
PO6
F1
F2
F3
A9
A10
A11
P7
P6
P5
A7
A8
A6
S15
S14
S13
P1
P2
P4
A4
A5
Ft. McMurray
A2
PO2
PO3
S10
S11
S12
A3
Peace River
P3
S9
S8
A1
L6
GO3
PO1
M-3
S4
L3
L4
G1
G2
S3
L5
G2C
SO2
L2
L8
L1
L9
Grande Prairie
Slave Lake
GO1
GO2
M4
GO4
S1
S2
S6
S7
LO1
Lac La Biche
G3
G4
G5
G6C
G7
W2
W3
SO1
M-7
G8
W1
W4
Whitecourt
W5
E10
E8
E7B
E6B
W7
0
50
100 km

MAP 1

FOREST MANAGEMENT UNITS

■ Hardwood supply areas

▨ Forest management and reserve areas

Current Utilization and Allocation

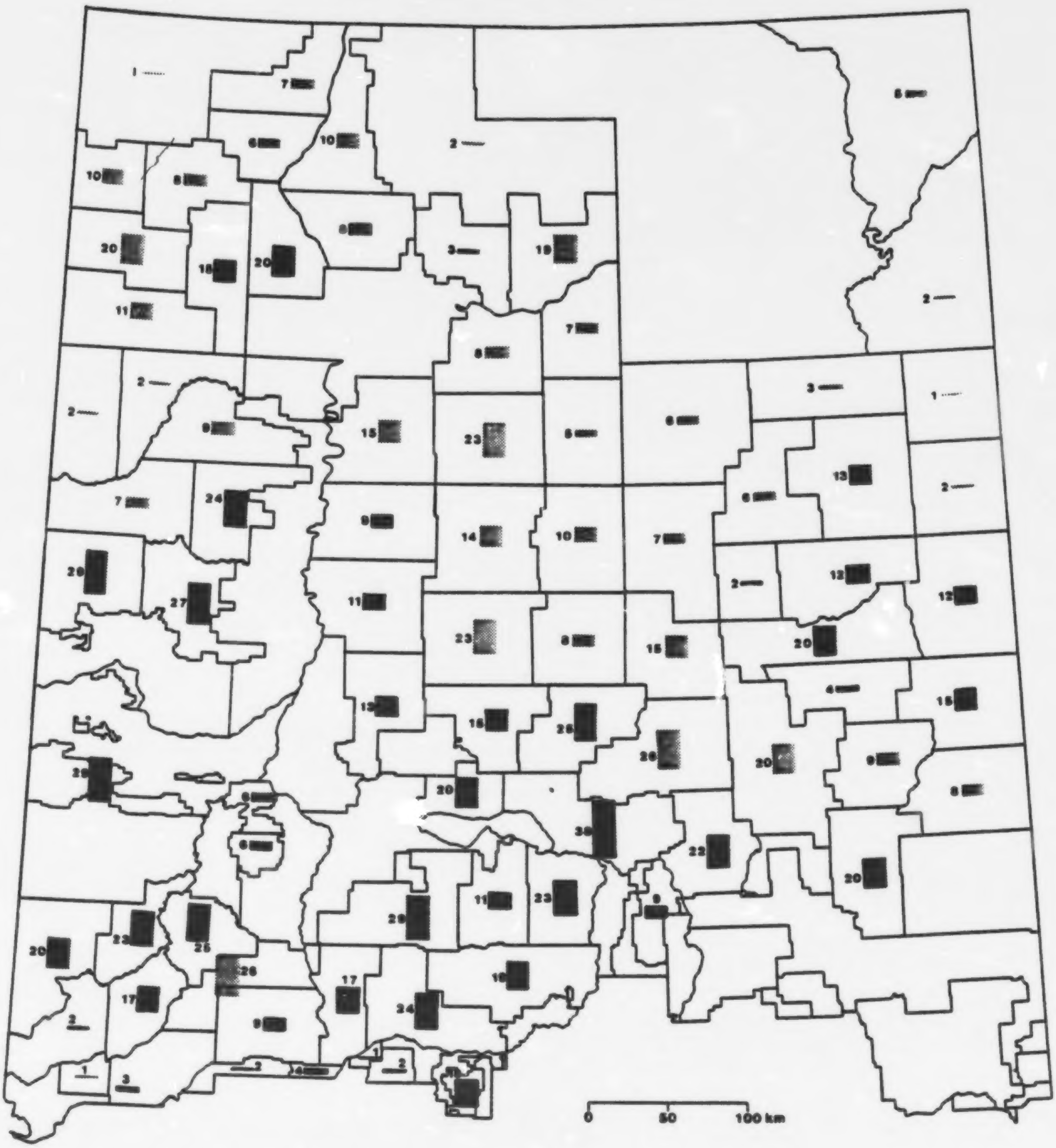
Two significant hardwood utilization facilities currently draw on the aspen resource of northern Alberta. These are panelboard plants located near Slave Lake and Edson, which have allocations from within the region of 250,000 and 62,000 cubic metres respectively. (The Edson plant obtains the balance of its allowable cut from outside the region.) Some exploratory use of aspen for kraft pulp has occurred in the Grande Prairie area. There is some miscellaneous use, primarily for firewood, for which birch is in high demand wherever it is readily accessible to local markets.

Map 1 shows the location of the supply areas for the Slave Lake and Edson plants. The Weldwood "search area" (this is the large hardwood supply area shown in Map 1; within this area the actual allocation required to maintain the Weldwood plant is currently being determined) occupies part of the Slave Lake Forest. The Company and the AFS are in the process of locating lands within the search area which will be dedicated to deciduous timber production as a forest management area, under a forest management agreement which is currently being negotiated. Management Unit W5 in the Whitecourt Forest contains a Deciduous Timber Allocation providing an AAC of 61,836 cubic metres of aspen to the Edson plant.

Map 1 also shows lands already designated by Orders-in-Council as forest management areas. Companies holding forest management agreements for these areas are not obliged to utilize deciduous timber but may, with the Minister's approval, harvest any portion or all of the hardwood AAC. Essentially, the Companies involved (Procter and Gamble Cellulose, Canadian Forest Products and Blue Ridge Lumber) have first option on the hardwood timber in their management areas. In the case of Blue Ridge Lumber this option extends beyond the management area to include Management Unit W2.

The distribution of AAC by forest management unit is illustrated in Map 2. The region contains approximately 10,391,000 cubic metres of hardwood AAC. This is about 90 per cent of the total provincial figure. It is distributed throughout some 85 forest management units in eight forests. AAC's calculated for the Yellow Area (areas outside designated forest units and usually in the Yellow Zone, designated for possible agricultural development) and Metis settlements have not been included, since these areas are not necessarily dedicated to long-term timber production. A detailed listing of unit hardwood AAC's is included in the Appendices.

Although these AAC's represent the government's formal estimates of sustainable harvest levels, they are based on data and assumptions, some of which the AFS regards as obsolete. The forest inventory data on which they are based have mostly been replaced by the recent provincial Phase III Forest Inventory, which will be used by the AFS for future AAC calculations. The earlier data used for calculating hardwood cuts are rendered obsolete by growth and mortality as well as by changes in forest inventory specifications.



MAP 2

HARDWOOD ANNUAL ALLOWABLE CUTS

Unit AAC's stated in cubic metres x 10,000

■ Most accessible ■ Intermediate ■ Least accessible

A rotation of 70 years was assumed for all hardwoods. This may be appropriate for pure hardwood stands managed for hardwood production, but is not necessarily applicable to mixed coniferous and hardwood stands, or hardwood stands with coniferous understories. The hardwood AAC's were calculated by von Mantel's formula, a traditional and simplistic approach developed for regulated German forests in the latter half of the nineteenth century. The formula assumes that the forest contains an even distribution of areas by age-class up to (but not exceeding) rotation age, and that there is a linear increase in volume by age-class. Thus the growing stock of the forest can be represented by a right triangle, the horizontal side being the age range and the vertical side representing the volume in the oldest age class. The actual distribution of volume by age class, as indicated by the Phase III inventory, does not conform to this model. A large proportion of the older age classes do not show a linear increase in volume with age and the age class distribution varies considerably between management units, frequently including significant volumes over rotation age. In this situation, there is a tendency for the straight-line relationship assumed in von Mantel's formula to overestimate the allowable cut (Davis 1966). This possibility is somewhat countered by the expectation that the inventory data to which the formula was applied were conservative and sub-merchantable growing stock was ignored.

Two other assumptions were made in the calculation of hardwood AAC's: 0.1 per cent of the growing stock would be lost to fire each year and 25 per cent of the harvested volume would be culled owing to defect. Annual fire losses, averaged over the last 20 years in northern Alberta, have exceeded 0.1 per cent of the total forest growing stock (including both softwoods and hardwoods), except in the Edson and Grande Prairie Forests. Hardwood stands are usually considered less flammable than softwoods, although no reliable statistics were available to separate what losses were incurred by just the hardwood growing stock. Future fire losses are expected to be reduced because of improved fire detection and manning. The 25 per cent deduction for cull was presumably intended to encompass other losses not specifically accounted for in the AAC calculation, such as those resulting from land-use restrictions, insects and disease.

Accessibility

The AAC statistics provided by the AFS indicate the quantity of the resource available for utilization. Although they incorporate assumptions regarding the minimum size of tree that can be utilized and make allowances for unusable defect, they do not incorporate or imply economic operability. In an extensive region such as northern Alberta, accessibility of the AAC relative to existing and potential manufacturing sites is obviously a critical factor in resource utilization.

The following procedure was used to provide an approximate breakdown of the total regional hardwood AAC according to haul distance and delivered cost.

The geographic centre of each forest management unit was measured for distance to the nearest potential manufacturing site. Roaded and non-roaded components of the haul distance were separated. Potential manufacturing sites were arbitrarily defined, usually as any village or larger community located on rail trackage.

A crude cost model was assembled to predict delivered cost (in dollars per scaled cubic metre) as a function of haul distance and road requirements (in kilometres). Details of the cost components and assumptions incorporated into the model are given in the Appendices. The resulting estimates of haul distance and delivered cost were applied to the unit AAC's to produce Table 3-1 which indicates the average cost and haul distance for incremental percentages of the total regional AAC.

Table 3-1

Estimates of Average Haul Distance and Delivered Cost for Incremental Percentages of Allowable cut, Ranked in Ascending Order of Cost

Per Cent of AAC	Average Haul (km)	Average Cost/m^3 ($)
0-10	36	19.30
10-20	43	19.95
20-30	50	20.63
30-40	65	22.10
40-50	78	23.42
50-60	92	24.64
60-70	115	26.65
70-80	143	28.68
80-90	161	30.28
90-100	216	35.67

The same information is represented graphically in Figures 3-1 and 3-2. In Map 2, histograms indicating unit AAC's have been shaded to differentiate management units into three categories, depending on whether their AAC falls into the lowest, intermediate, or highest third of the total regional AAC with respect to delivered cost. A listing of management units, ranked in order of ascending delivered-cost and their AAC's, cost per cubic metre and hauling distances, is presented in the Appendices. It should be noted that the costs and haul distances are based on some simplistic assumptions and a very cursory examination of costs and locations. They are intended to provide only an approximate quantification of the accessibility of the regional AAC.

Figure 3-1

Average Haul Distances Involved in Delivering the Hardwood Allowable Cut of Northern Alberta to Potential Manufacturing Sites

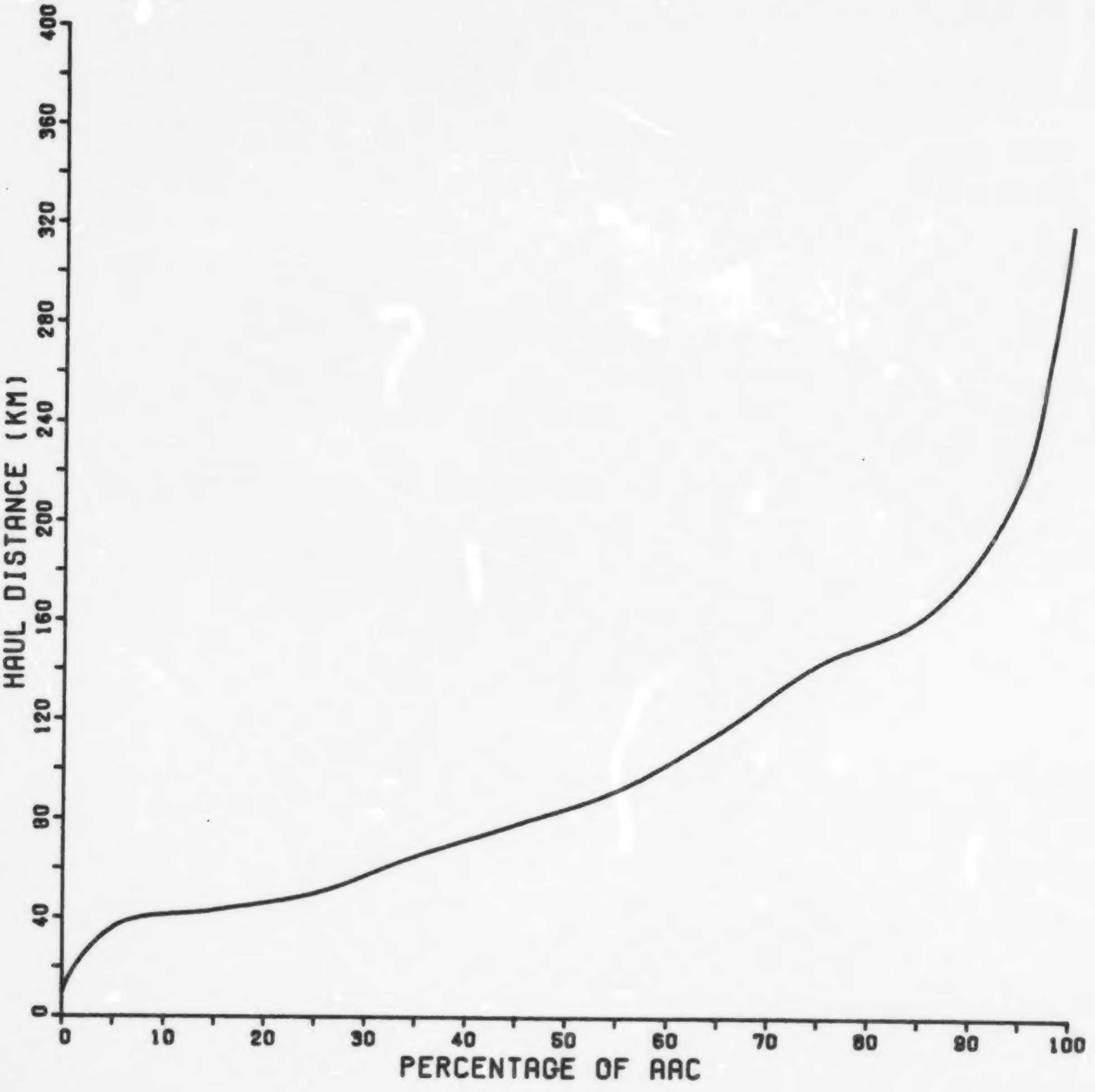
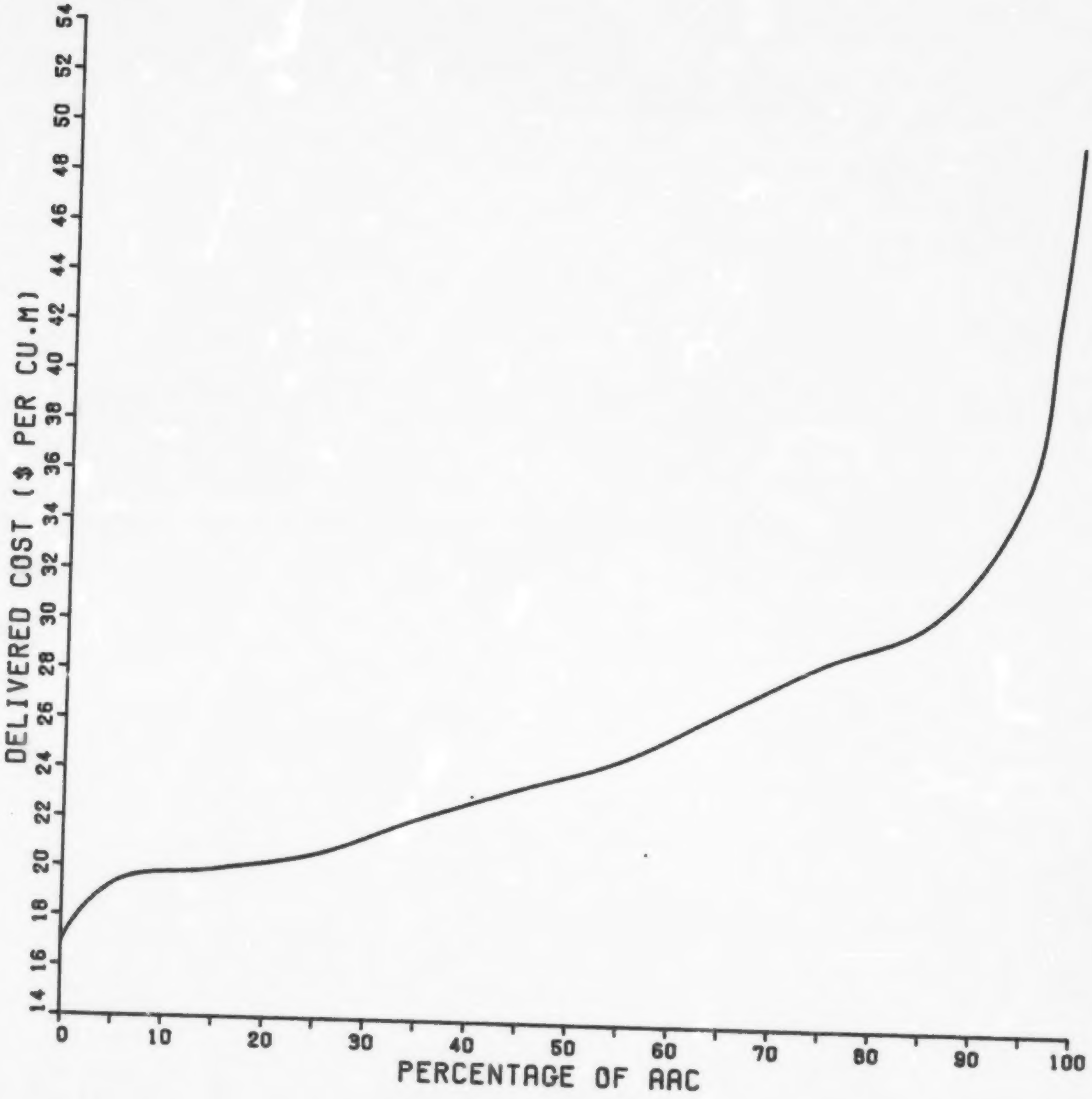


Figure 3-2

Costs per Cubic Metre for Delivering the Hardwood Allowable Cut of NOrthern Alberta to Potential Manufacturing Sites



Existing hardwood operations in Alberta and Saskatchewan are generally finding sustained haul distances over 50 miles (80 km) uneconomic and are attempting to maintain shorter average haul distances. It will be noted from Figure 3-1 that restricting haul distances to less than 80 km would render about 50 per cent of the available AAC inaccessible. This estimate is probably overly optimistic because it is very unlikely that manufacturing facilities can be located at the nearest "potential" manufacturing sites to all management units.

Projections Based on New Data

New forest inventory data, not yet incorporated into formal AAC estimates, are available for much of northern Alberta. Some forest management units have not yet been re-inventoried (see Map 3); these are units given low priority by the AFS and all fall into the least accessible category recognized in Map 2. The parts of the 'O' areas (areas outside designated forest units) which have been omitted from the new inventory generally do not contain significant amounts of timber.

The volume projections described below are based on the new "Phase III" data from the completely re-inventoried management units. They have been adjusted to represent the entire forest area by extrapolation according to the old inventory estimates of stocked productive land in units not covered by Phase III.

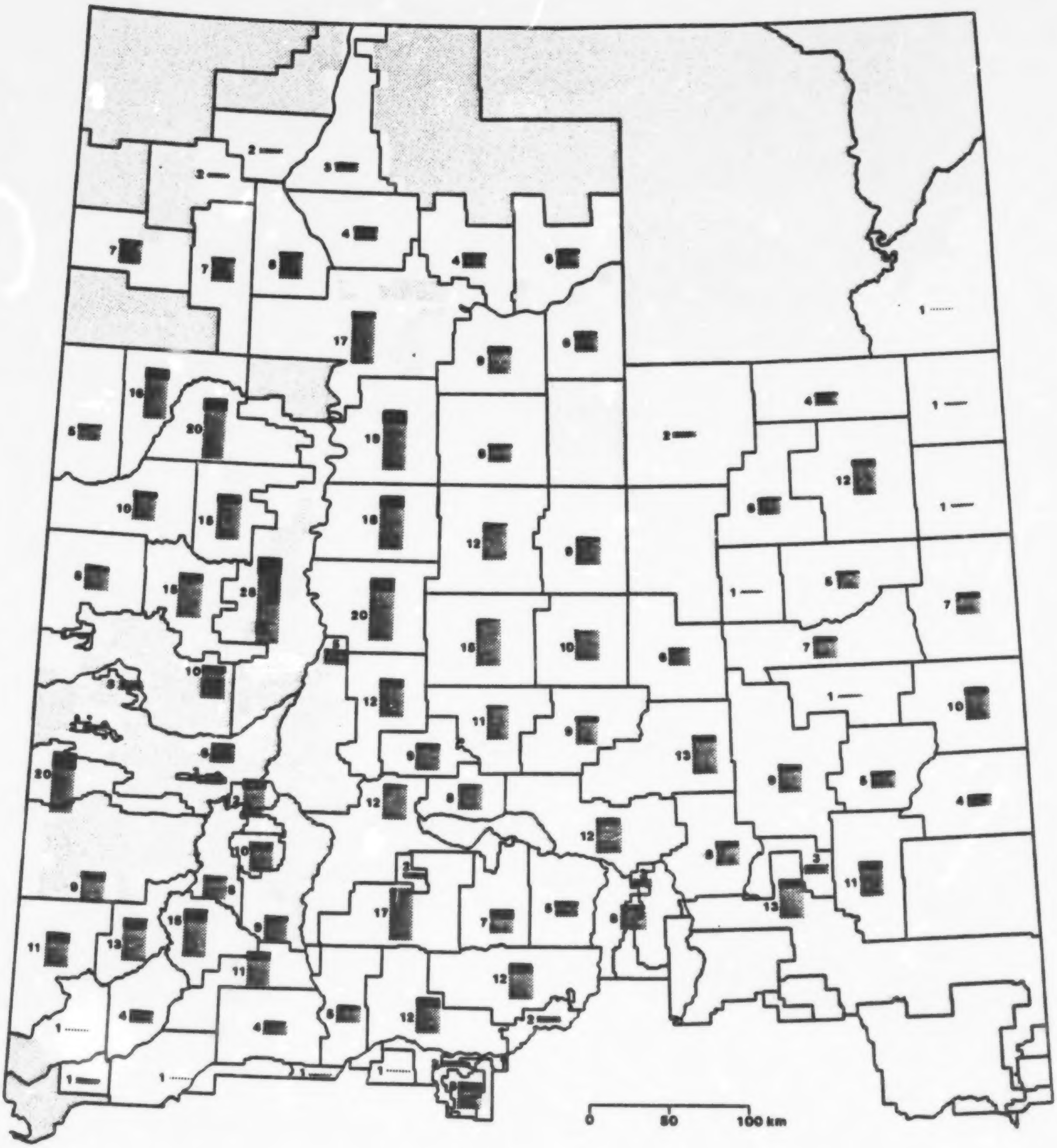
Updated Allowable Cut

The first projection made was a recalculation of the regional hardwood AAC, approximating as closely as possible the methodology used for the original AFS estimate (i.e. von Mantel's formula). The recalculation was based on an estimated total hardwood growing stock on re-inventoried units of approximately 699 million cubic metres, measured at the "15/10" utilization standard and excluding volumes in the Yellow Area, Metis settlements and softwood stands. This resulted in a projected increase in the net regional AAC of 54 per cent to 16,018,000 cubic metres per year. The increase may be attributed to conservatism in the old inventory data, a real increase in growing stock over the last two decades, or a combination of both.

The distribution of hardwood growing stock, by management unit and species, is illustrated by Map 3. The overall regional breakdown of net merchantable volume is in the order of 81, 15 and 4 per cent aspen, balsam poplar and birch respectively. Some of the largest accumulation of hardwoods are in the Yellow Area such as FO1 and PO3, which are not necessarily dedicated to long-term forest production.

Area-Volume Analyses

The AFS no longer recognize von Mantel's formula as a suitable basis for calculating timber supplies, for reasons already described. Recent softwood allowable cut decisions have been based on the "area-volume check



MAP 3

VOLUME AND SPECIES DISTRIBUTION

▨ Trembling aspen ▨ Balsam poplar ■ White birch

Net merchantable volume (all species, 15/10 utilization standard) stated in millions of cubic metres

▩ non-inventoried areas

method" or similar approaches. This involves projecting annual harvests at a trial AAC level, calculating the time taken to cut each age class according to the area of the class and its expected volume yield, and accumulating the time taken to work through the forest from the oldest to the youngest age classes. If the projected time taken to harvest the entire forest does not coincide with the selected rotation, the trial cut level is raised or lowered and the whole process if reiterated until a level of cut is found which liquidates the forest in the required rotation period.

This approach can be used to evaluate the impact of age-class distributions, various yield and defect assumptions, and alternative rotation and harvest-scheduling policies on timber supplies; it is also simple and endorsed by the AFS. It was therefore used in this study to evaluate potential hardwood supplies from the northern Alberta region as a whole. Time prohibited separate analyses of each management unit. It should be remembered that age class distributions at the management unit level can vary widely from the average condition. This may create local circumstances significantly different to those indicated by this study for the region as a whole. Local age-class inbalances will tend to result in the single regional analysis somewhat overestimating timber supply relative to that which would be indicated by aggregating the results of separate analyses for each unit.

Several assumptions, not explicitly recognized in the previous AAC calculations, were incorporated into the regional analysis. The decay-age relationship, illustrated in Figure 2, was applied to the Phase III inventory data to obtain estimates of net volume (i.e. volume which would be scaled as sound). Hardwood stands were differentiated from mixedwood stands, since (under existing policy) mixedwood stands are scheduled for softwood rotations. Approximately 14 per cent of the hardwood stands, which were classified as having predominantly coniferous understories, were withdrawn from the hardwood projections, on the assumption that they will be retained and harvested for their coniferous component, by which time the hardwood component will be unusable. The methodology used in the Phase III inventory, whereby interpretation of infra-red aerial photography, (taken during the summer when the trees have leaves) is used to classify forest stands, does not lend itself well to the identification of understories. This may have been partly compensated by extensive ground-checking, but it is possible that the extent of coniferous stocking under hardwood stands has been underestimated.

One of the most important assumptions in the estimation of timber supply is the net volume of wood which will be yielded per hectare at the time of harvest. Taking into account the dynamic nature of forest yields is particularly important for aspen, since recoverable yields of this species will change relatively quickly with age as a result of growth and decay. Average volumes per hectare by age-class, as estimated from Phase III data and the decay-age model (see Figure 2-2), are presented in Appendix A6 for hardwood and mixedwood stands in northern Alberta. These data show some inconsistencies relative to our expectations: namely higher yields from young stands (e.g. about 100 cubic metres of merchantable roundwood at 45 years) than would be expected in empirical regional averages and rather irregular trends with age in older stands. Three possible explanations may be offered for the high early yields: the young stands happen to occur on good sites with near-optimal stocking, our expectations for young stands are unduly pessimistic, or the effect is an artifact produced by statistical error in the age data. Given the uncertainty over the volume-age trend, the average volume per hectare in mature stands was calculated from the Phase III data and this volume was projected for all stands harvested within the "mature" age range. This age-range was defined as 50 to 135 years for pure hardwood stands and 80 to 170 years in mixedwoods. The definition of maturity in the mixedwoods was predicated on softwood rather than hardwood growth rates.

The average net merchantable volume per hectare for hardwood stands is estimated at 100.9 cubic metres per hectare. This was projected in computerized area-volume analyses with alternative rotations of 40 to 70 years. Deductions for fire losses (0.1 per cent of the growing stock per year) and adjustments for non-inventoried areas were made to the resulting projections. The analysis indicated a supply of 6,121,000 cubic metres per year from pure hardwood stands in northern Alberta, liquidated on a 70-year rotation. The change in cut resulting from reducing the rotation and the projected cutting-ages and decay levels for the first 20 years are shown in Table 3-2.

Table 3-2

Impact of Various Rotations on Cut Levels, Age and Defect at Harvest

			1st 20-yr. Harvest	
Cover-type	Rotation (yrs.)	Annual Cut*	Age (yrs.)	Aspen Decay (%)
Hardwood	70	100	104	25
	60	116	100	22
	50	140	96	20
	40	174	90	17
Mixedwood	120	100	142	(57)
	100	120	139	(54)
	80	150	136	(51)

* Expressed as percentages of cut level based on 70 and 120 year rotations for hardwood and mixedwood types respectively.

Similar analyses were conducted for the mixedwood stands, but these assumed an average hardwood volume per hectare of 55.5 cubic metres, with alternative rotations of 80 to 120 years. The analyses indicate that a hardwood supply of 1,389,000 cubic metres per year would be generated by liquidating mixedwood stands on a 120-year rotation aimed at softwood recovery. Table 3-2 indicates the dilemma of mixedwood stand management. Given current policies for optimizing softwood yields and early removal of the older high-risk timber, liquidation at a rate providing sustained softwood production will result in harvesting-ages and decay-levels over the foreseeable future which are excessive for economic hardwood recovery, particularly of aspen. There will certainly be exceptions where mixedwood stands can be harvested at younger ages without adversely affecting softwood supply schedules (e.g. some mixed pine-aspen stands), but the general situation in northern Alberta makes recovery of both softwood and hardwood components of mixed stands difficult. The decay situation in both pure and mixed hardwood stands will presumably deteriorate the longer that the stands are protected but unutilized or underutilized. Two-entry logging systems for harvesting the hardwoods first and returning later for the softwoods may be feasible in some circumstances (Froning 1980).

The combined annual cut for northern Alberta, assuming 70 and 120 year rotations for pure and mixed stands respectively and calculated as described above, is 7,509,000 cubic metres. This is 28 per cent less than the current AAC figure. The cut could be increased by reducing the liquidation period and improving utilization standards (i.e. harvesting trees smaller than the 15/10 specification); and the assumed volume yields may be conservative (see below). However, the long-term sustention of harvests based on shorter rotations, with the exception of utilization for pulp which will be further discussed, is questionable, as is the economic feasibility of improved utilization standards. Accelerating the harvest to non-sustainable levels would have the positive effect of reducing harvesting ages and hence decay levels. Assuming a market for the wood, increases in cut and the desirable removal of aging stands will have to be traded off against the possibility of not being able to maintain long-term timber supplies. The AFS have adopted a 40-year liquidation period for the aspen stands allocated to the Edson panelboard plant, but such a policy would not necessarily be applied in general.

Some of the the Yellow Areas have considerable potential for augmenting AAC's. The sustention and magnitude of this supply is uncertain however, since it will depend on the rate of expansion of other land-uses primarily agriculture.

Projections Incorporating Utilization Constraints

The levels of decay forecast by Table 3-2 for aspen from mixedwood stands are prohibitive to economic utilization. The levels forecast for aspen from pure hardwood stands, whilst not as bad, are still excessive for many manufacturing processes.

There is some opportunity for pre-selecting the better quality wood during the logging operation. More research into decay assessment in standing timber would probably be useful. However, the irregular distribution of decay within trees and stands limits the extent to which pre-selection can effectively reduce defect levels in delivered wood without incurring a high degree of wastage, which in turn reduces the sustainable supply and increases delivered cost (not to mention creating environmental and silvicultural problems).

Projections were made of regional supplies possible under management strategies for reducing decay in harvested timber to two alternative levels (10 and 20 per cent) by constraining the maximum ages of stands harvested. We attempted to make the projected volume yields more realistic than the static estimates of mature volume used in the previous area-volume analyses. This was done by adopting a "normal" yield table approach, whereby the volume-age curve in Figure 2-3, curve c was adjusted to the inventory estimate of stocking for each age class and then used to project future yields for each class. Phase III inventory data indicated excessively high empirical stocking levels relative to Figure 3c in age classes of 55 years and less. A stocking level of 72 per cent was assumed in these classes, this being the average observed in stands 60 to 95 years old.

An initial projection was made identical in all respects to the previous area-volume analysis for pure hardwood stands on a 70-year rotation, except that the estimated average volume at maturity was replaced with separate estimates for each age class projected as described above. This indicated that the pure hardwood stands of the region could sustain an annual cut of 7,808,000 cubic metres (28% higher than the equivalent projection based on the simple area-volume analysis), but that decay levels would be excessive assuming initial removal of the older stands was required (See Table 3-3).

Further projections were then made to investigate the effect of constraining decay levels to 20 and 10 per cent by excluding classes older than 95 and 75 years respectively from the analysis. Results are summarized in Table 3-3, details of the actual simulations are presented in Appendix A8. Cut levels in Table 3-3 have been adjusted for fire losses and non-inventoried areas, but no allowance has been made for inaccessibility. No projections were made for mixedwood stands, because of the high average level of aspen defect which results from managing such stands for softwoods.

Table 3-3

Projected Supplies from Pure Hardwood Stands under Alternative Management Strategies

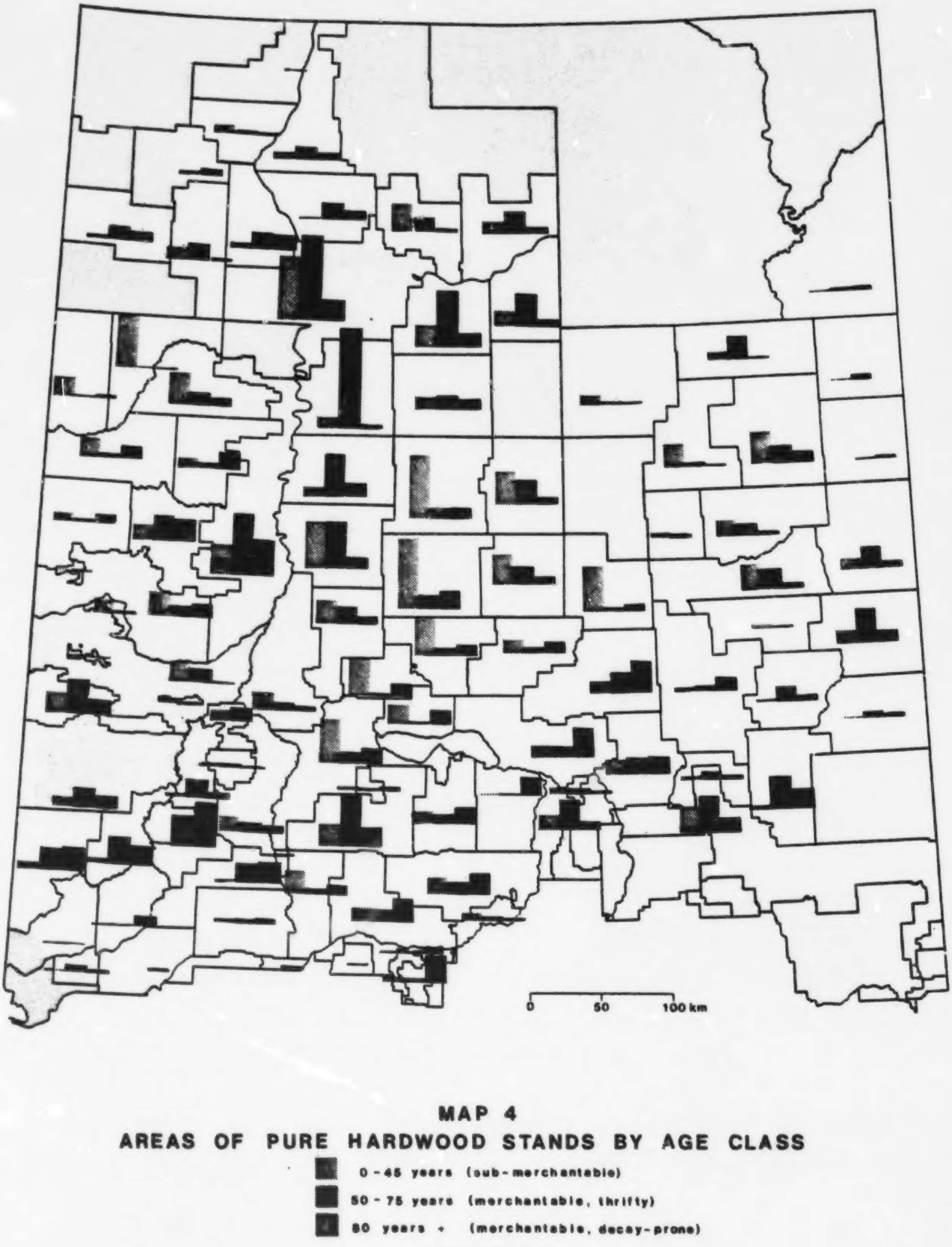
Maximum Age at Harvest*	Maximum Per Cent at Harvest*	Rotation (years)	Annual Cut (m^3x1000)	Per Cent of Regional AAC
135	50	70	7,808	75
95	20	70	6,916	67
95	20	60	7,843	75
75	10	70	5,876	57
75	10	60	6,459	62

* Applies to first 20-40 years; these limits may be exceeded later in the rotation due to age-class imbalances.

Rotations of both 70 and 60 years were tested. Although contrary to Kirby's conclusions (Kirby et al 1957) and assumptions used for calculating existing AAC's in Alberta, the shorter rotation appears to be justified if the end-use requires a low level of defect, but can accommodate small tree sizes. Under average stocking and site conditions a merchantable crop of pulpwood can be grown in 60 years. (Well-stocked stands on good sites can be produced on shorter rotations, but the converse is true for poor stocking or site conditions.). Furthermore, our analyses suggest that the large concentration of aspen stands in northern Alberta, currently in the forty-year age range, will exceed 75 years of age when harvested, even if full utilization at the annual cut levels indicated in Table 3-3 commenced immediately. Therefore, when harvesting is economically feasible, liquidation on rotations shorter than 70 years would have the positive effect of reducing the accumulation of decay-prone age classes.

The best opportunities for those hardwood operations which are sensitive to defect, but which are able to utilize small trees, appear to exist in management units with concentrations of pure hardwood stands less than 75 years of age, without coniferous understories (see Map 4).

The opportunities are much more limited for products requiring larger, but also sound, trees. Figure 3-3 shows trends of average tree diameter with age in pure aspen stands. These trends are general and tentative, but note that, with the possible exception of good sites, average tree diameters do not exceed 30 cm until ages associated with high decay levels. "Good" sites occupy only about 10 per cent of the hardwood areas in northern Alberta. Nevertheless, small flexible operations exploiting local occurrences of good-quality timber may offer significant, if not extensive, opportunities for specialized small-scale ventures. Tree size and soundness may be generally better in balsam poplar than in aspen, but the utilization of balsam poplar for most specialty and lumber products is severely limited by the occurrence of stain.

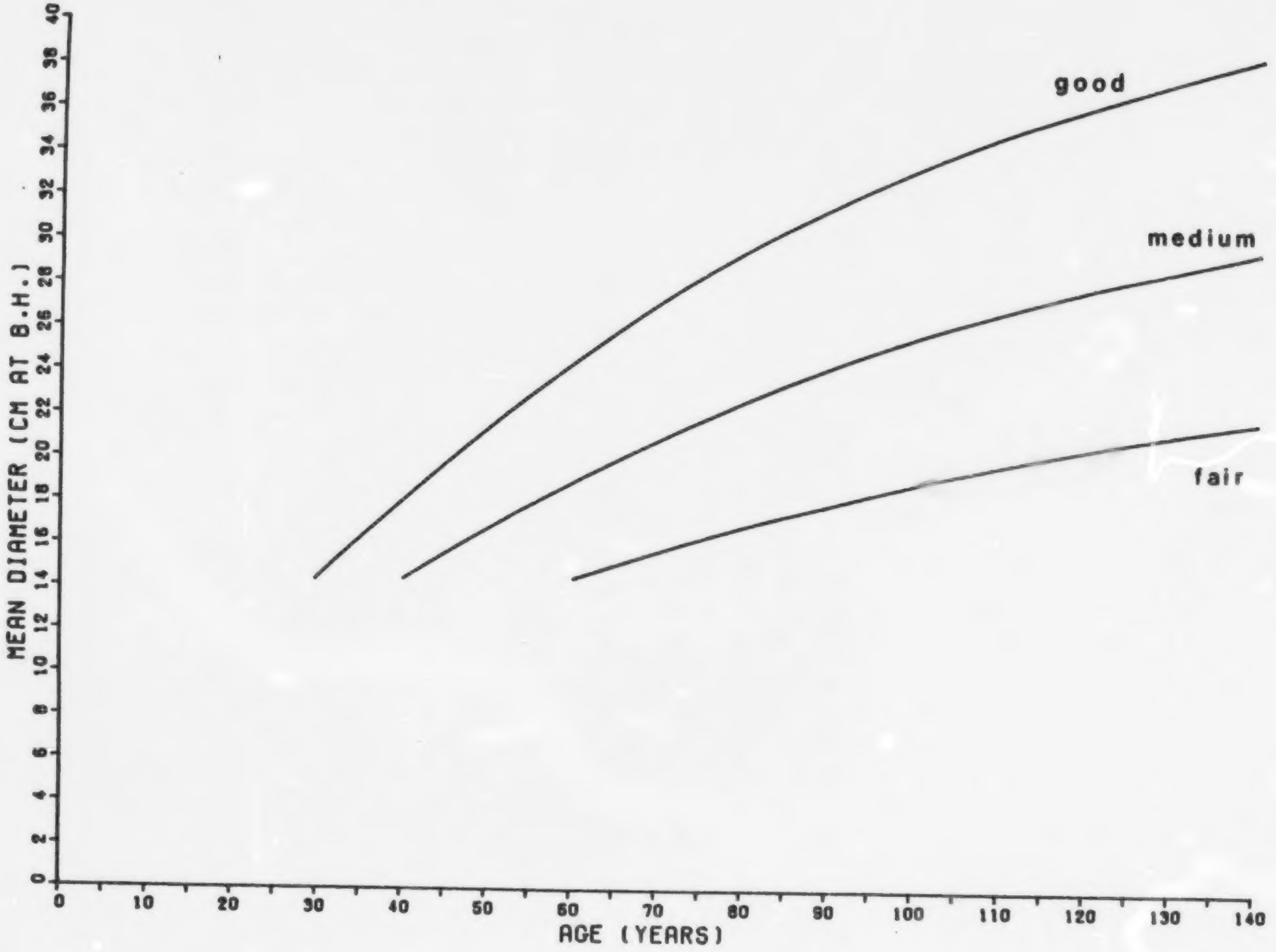


MAP 4
AREAS OF PURE HARDWOOD STANDS BY AGE CLASS

▨ 0 - 45 years (sub-merchantable)
■ 50 - 75 years (merchantable, thrifty)
▦ 80 years + (merchantable, decay-prone)
▬ 10,000 ha
◆ non - inventoried areas

Figure 3-3

Hardwood Tree Size in Relation to Age
on Good, Medium and Fair Sites



Implications for Forest Policy and Research

Defect and inaccessibility are likely to continue limiting the proportion of the hardwood AAC which is economically operable. Growth and decay rates alone probably restrict the sustainable regional supply to between about six and eight million cubic metres per year. Whilst this is less than the formal AAC, it is a very significant potential resource, on a scale with hardwood production in the Lake States. Even assuming 50 per cent of the AAC having adequate quality cannot be utilized owing to access constraints, utilization of three to four million cubic metres of hardwood per year in northern Alberta would represent a tremendous opportunity and challenge. It would be about ten times the volume currently being harvested.

The trend, especially in aspen, towards decay and breakup at early ages relative to softwoods cannot be ignored. It does not bode well for integrated operations. Utilization for pulp will probably have to rely on small, low-defect green wood, rather than byproduct chips from solid-wood product manufacture. Opportunities for utilizing both conifers and hardwoods from mixed stands are quite limited. It is interesting to compare this situation to the evolution in the Lake States of a largely non-integrated industry, with a high proportion of the resource being dedicated to short-rotation pulpwood production.

The most important implication of the defect observed in aspen is that a significant, and probably increasing, proportion of the existing growing stock is unusable for the manufacture of marketable products. In order to facilitate orderly but feasible resource development, this will have to be recognized and dealt with at all levels of forest policy and decision-making, from yield-regulation policy at the regional level to decisions concerning the operability of individual stands or parts of stands.

The recognition that successful economic utilization of hardwoods will involve avoidance of the overmature and more decadent stands (rather than their early liquidation which has been a wise and workable tenet in softwood management) raises the question: what should be done with such stands? There are really only three options: regenerate aspen, artificially convert to another species or allow natural succession to take its course. The former two are difficult to justify under conventional investment criteria because of relatively slow growth rates and uncertainties over future markets, but may offer substantial long-term benefits as well as immediate employment opportunities. The third option is likely to result in land being non-productive for an extended period of time.

Zehngraff's comments regarding possibilities for managing aspen in the Lake States over 35 years ago (Zehngraff 1947) have some relevance to northern Alberta hardwoods today and particularly to forest inventory and research priorities. He pointed out that on large holdings, many of which presently lack even the crudest management, intensive and sophisticated management is initially unrealistic, but that efforts should be concentrated on the simple but careful regulation of the resource, primarily according to its age-class distribution.

Thus the key information required by the manager is age and site classifications of the land base and associated data on stocking and productivity. In addition to examining available forest inventory data, we have reviewed a large amount of research literature, much of which is orientated towards the intensive management of stands after initial logging of the existing timber. Ironically, we have encountered:

- no concerted comprehensive research effort to predict decay in Alberta hardwoods,
- no generally accepted accurate basis for estimating the growth of existing stands,
- age and site data which, because limited forest inventory resources have necessarily been concentrated on the coniferous species, are cursory and sometimes questionable.

Rectification of these shortfalls will be necessary to facilitate appropriate development of the resource.

CHAPTER SUMMARY

- The situation regarding current annual allowable cuts has been described, together with estimates of the haul distances and costs which would be involved in delivering the allowable cut to potential manufacturing sites.

- The annual allowable cut (the volume of hardwoods which may be harvested under the authority of The Forests Act) for Northern Alberta is approximately 10.4 million cubic metres, theoretically enough to supply about 40 panelboard plants or seven bleached kraft pulp mills.

- However, the formal allowable cut estimate does not mean, or necessarily imply, that such a volume could be harvested in practice.

- The level of harvest which is actually achievable depends on a number of uncertain factors including markets, growth and depletion rates, defect, delivered cost, agricultural expansion and policy requirements for the long term sustention of both hardwood and softwood resources.

- Projections, based on new inventory data, were made of possible harvest levels under a number of management and utilization alternatives.

- Even if markets do become available, only a proportion of the allowable cut, perhaps three to four million cubic metres per year, are likely to be useable on an economic and sustainable basis.

- Although less than the allowable cut figure, this represents a large and exciting opportunity, involving ten times the current level of hardwood utilization.

- Successful exploitation will require recognition that a significant proportion of the existing growing stock cannot be manufactured economically, and improved information on decay, age and growth is needed for identifying the location and quantity of wood which has real potential.

4.0

FIBRE REQUIREMENTS AND AVAILABILITY FOR SPECIFIC UTILIZATION ALTERNATIVES TO BE DISCUSSED IN SUBSEQUENT SECTIONS

New forest inventory data indicate a fairly dramatic re-assessment of the distribution of hardwood supplies in northern Alberta, relative to the old allowable cut data shown in Map 2. Note, for example, that Map 3, relative to Map 2, shows a higher concentration of volume northwest of Slave Lake, and lower concentration east and south of Slave Lake. Furthermore, this trend is accompanied by a better age-class distribution: note in Map 4 the large areas of young (and hopefully healthy) stands occurring in a north-south line west of Slave Lake, extending from High Level in the north to unit W2 in the south.

Compare this to the concentration of older decay-prone stands in many of the Slave Lake and Whitecourt units which have high AAC's. Indeed, the two trends are probably related. The old AAC's are based on 20-year-old merchantable volume inventories, and calculated without reference to decay-age relationships. Areas, which at the time of inventory were sub-merchantable, were not incorporated into the AAC calculation. Apparently, many such areas have now been picked up by the latest inventory, and, in our opinion, it is these thrifty young stands which offer the best development opportunities.

It is also interesting to note, by reference to Maps 1, 3, and 4, the high volumes of aspen, generally with good age-class distributions, occurring in the Yellow Areas of the Peace River, Grande Prairie, Footner, and Lac La Biche forests. These areas are not necessarily dedicated to long-term forest management, contain private as well as Crown lands, and are probable zones for agricultural expansion. Although the timber supplies in these areas will not be allocated to long-term forest tenures under current land-use policy, they will logically play a significant role in hardwood manufacturing development, since they are large, accessible, and their utilization could enhance the viability of existing and expanded agricultural operations.

The fibre requirements of specific options (discussed from a technical, market and economic viewpoint in subsequent sections) will now be considered.

A. Aspen Bleached Kraft Market Pulp - Fibre Requirements

Annual fibre requirements are in the order of 1.4 million cubic metres of roundwood (net of defect). Maximum decay levels in delivered wood are probably about 20 per cent, although levels approaching this would create substantial increases in logging and manufacturing costs. Small trees can be utilized. Water and infrastructure requirements are critical factors in facility location, and are not addressed in detail here.

Ignoring for a moment water availability and the previous comments on AAC distribution, basing the selection of candidate areas simply on the distribution of AAC (see Map 2) would indicate the highest concentration and hence the best opportunity, in the eastern Slave Lake area (over two million cubic metres of AAC available within a 100 km radius), followed by Whitecourt and Grande Prairie (each having over one million cubic metres of AAC within 100 km.).

However, in view of the probable shift in AAC distribution discussed above, the availability of "non-forest' wood, and the situation regarding existing commitments (see Map 1), we suggest that the best opportunities exist in the Peace River Forest, the area west of Slave Lake, or the Grande Prairie area.

The area west of Slave Lake appears to contain about one million cubic metres of AAC mostly within a 100 km. radius, with a good age-class distribution. Whereas in some of the eastern Slave Lake units we anticipate AAC's may be overly optimistic, the converse may be true for the area in question. In addition a significant supplemental volume could be acquired from the Yellow Areas and Metis settlements. The hardwoods in the area are largely uncommitted. The biggest resource constraint for kraft development in the area is presumably water availability.

Grande Prairie ostensibly has over one million cubic metres of hardwood AAC within 100 km. However, some of the supply units contain significant components of older wood, supplemental sources are limited, and we do not know whether this cut level is achievable. Given that much of the available hardwood resource lies within their lease area, utilization here will depend very much on Procter and Gamble Ltd.

The Peace River area merits further examination. The most hopeful location would probably be downstream from the town of Peace River, perhaps at Manning. Current AAC estimates indicate about 840,000 cubic metres within 100 km. If the new inventory data are correct, this figure is probably not only attainable, but conservative. If these data are going to result in AAC increases anywhere in the Province, it will probably be in the Footner and Peace River management units on the east side of the Peace. These units would only be accessible to Manning during the winter, but a large supply of summer wood would be attainable from the Procter and Gamble Reserve Area and supplementary sources. A very significant supply could be obtained from non-forest sources. Management unit PO3 alone contains at least 28 million cubic metres of standing inventory (see Maps 1 and 3). Access to the Procter and Gamble Reserve Area would be a prerequisite for this option.

B. Aspen/Spruce Bleached CTMP - Fibre Requirements

Annual fibre requirements are in the order of 260,000 cubic metres of hardwood, plus 240,000 cubic metres of softwood, which could be acquired in the form of residual chips from sawmill operations. Quality requirements are more stringent than for kraft, and we are assuming an upper decay limit of 10 per cent. Water requirements are only one twentieth of those for kraft manufacture.

Several potential locations can be identified. We have preliminarily identified eight of these, and reviewed them with regard to the quantity of hardwood and of softwood chips economically available, existing tenurial commitments and utilization, and quality of the available hardwood (see Table 4-1).

Table 4-1

Preliminary Locational Evaluation of Northern Alberta's Hardwood Development Potential for Aspen/Spruce Bleached CTMP

Forest Location	Quantity of hardwood economically available	Quality of hardwood	Adequate potential softwood chip supply	Existing tenurial commitments on AAC	Hardwood AAC already partially utilized[3]	Option retained
Footner lake	ok	ok	yes	no	no	yes
Peace River (Manning)	ok	ok	yes	yes	no	yes
Grande Prairie	ok	ok	yes	yes	yes[4]	yes
Slave Lake (Mitsue)	ok	?	yes	yes	yes	no
Slave Lake (High Prairie)	ok	ok	yes	no	no	yes
Whitecourt	ok	?	yes	yes	yes[5]	no
Lac La Biche	ok[1]	ok	no	no	no	no
Athabasca (Fort McMurray)	ok	ok	no	no	no	no

1 Assuming AAC can be supplemented from outside areas.
2 Selection of better stands is assumed permissible. "?" indicates that hardwood quality may be inadequate.
3 Minor dispositions (fuelwood etc.) not included.
4 P & G, on an experimental basis.
5 Pelican draws from this area.

Four locations have been retained as potentially feasible. The Whitecourt and Slave Lake (East) locations have been provisionally rejected primarily because of anticipated decay problems. Adequate chip supplies are not readily available in the Fort McMurray and Lac La Biche areas. Facilities located in the Peace River or Grande Prairie areas would be at least partially dependent on lands over which P & G currently hold tenurial options.

C. Panelboards - Fibre Requirements

Waferboard/OSB

Annual fibre requirements for the smallest economy of scale plant are around 130,000 m^3. Only hardwood is required. The significance of decay is essentially economic and depends on how advanced the decay is in the log. If it is well advanced then the fibre crumbles and cannot be used to form the board. Consequently a greater volume of fibre is needed to produce the design volume of board. Alternatively, less advanced decay is acceptable if the wafer or strand maintains integrity through the process. Hence any of the eight locations in Table 4-1 are potentially suitable. It should be noted that the high moisture content of balsam poplar can cause significant drying problems particularly if mixed with aspen.

MDF

Annual fibre requirements for a single refiner plant are approximately 225,000 m^3 based on roundwood input. However, low cost residual chips from softwood lumber operations are often the most economical source of fibre for MDF. Apart from economic considerations, the process is reasonably tolerant to decay in, for example, aspen logs. Board quality could be affected at very high levels, however, therefore a maximum of 20 per cent decay should be considered. Any of the sites identified for waferboard/OSB would be potentially satisfactory.

Plywood

The quality requirements for a standard plywood plant are so critical that is is unlikely that any site would provide a sufficient volume to sustain an economically sized plant.

There may, however, be sufficient high quality logs in certain areas to provide the necessary volume for a very small specialty plywood mill producing multi-ply solid core products for specific uses such as cabinetry. At least 12" to 15" diameter logs with minimal decay would be needed but inventory data are not adequate to identify specific locations.

D. Solid Wood Products - Fibre Requirements

Construction Lumber

The annual fibre requirements for a small/medium sized sawmill producing around 30 million board feet of lumber would be about 150,000 m^3 assuming a reasonable lumber recovery factor. However, since it is not believed that a standard construction grade lumber mill is viable based on the type of aspen available, a detailed analysis of potential sites has not been undertaken.

Specialty Lumber

The fibre requirements for a mill producing specialty lumber would vary significantly depending on the approach taken. Examples would be as follows:

1. A satellite operation linked to a pulp mill facility (refer to Section 7.0) could need 50,000 m^3 of good quality log input (12" diameter minimum and under 10 per cent decay). This would be needed to produce 5 million board feet of lumber suitable for further sawing and manufacture into high value products with a very small proportion of falldown. The balance of the fibre would be sent directly back to the pulp mill chipper infeed. Consequently the actual fibre use by the satellite operation would be relatively low even though an initial input of 50,000 m^3 is required.

   The suitability of any particular site in the area is difficult to predict. The principal operation would be the pulp mill and the objective of the satellite operation would be to add value to a small part of the fibre input. It is likely that the viability of such an operation would only be established once some experience of the actual log diet over time has been ascertained. The inventory and decay information available to us at the present time indicate that it may be difficult or impossible to locate 50,000 m^3 of available hardwood annually, meeting the above size and decay specifications and producing chips of adequate quality for pulp production.

2. **Small community based operations**

   These could be very small individually with any one operation producing less than 1 million board feet and requiring no more than 6/7,000 m^3 of logs annually. Assuming that the objective will be to produce primarily high value lumber with minimum volumes of low value products such as pipe racks, then only the premium quality of logs can be used. It is certain that there are many small pockets of aspen where such quality is available in sufficient volume but they tend to be within much larger licence areas. Consequently, given that the small local community sawmill would be adding greater value than the principal user in the area and that there could be significant social benefits, some policy provision may be justified for protecting these opportunities when areas are allocated for other purposes.

At this stage there are probably insufficient detailed data to identify the specific locations which could support the type of specialty sawmill contemplated.

CHAPTER SUMMARY

- Hardwood supplies sufficient, and of suitable quality, to support a market kraft pulp mill exist in the Peace River and Grande Prairie Forests, and in the western part of the Slave Lake Forest. Probably the best opportunity for a stand-alone kraft operation would involve a mill location on the Peace River.

- Potential locations for a CTMP mill, according to our preliminary assessment of hardwood quality and availability, softwood chip supplies, and current resource allocations, are High Level, Manning (north of Peace River), Grande Prairie, and the High Prairie area.

- The above locations might alternatively be used for siting panelboard operations, which could also be supported at Slave Lake, Whitecourt, Lac La Biche, or Fort McMurray.

- Opportunities exist for small-scale specialty manufacture, but it is not possible within the scope of this study to identify the most suitable locations.

5.0

THE USE OF NORTHERN ALBERTA'S HARDWOODS IN PULP AND PAPER

Technically, it is possible to produce a very wide range of pulps and a variety of papers and paperboards from northern Alberta's hardwood species. Previous studies[1] have reviewed most of these technical options and have dismissed many of them from further consideration because of market or economic limitations, or both. For the purposes of this study, a brief review of these ranking conclusions was carried out. The results generally verify the conclusions of the previous studies. However, additional market analysis carried out in this study, suggests that a slightly different ranking is justified in the ratings of the product options considered to have greatest investment potential for northern Alberta.

Table 5-1

Pulp & Paper Options Considered*

Pulp
(Captive Market)

High Fibre Yield
(Mainly Partial Aspen Furnish)
Stone groundwood (SGW)
Pressure groundwood (PGW)
Refiner mech. pulping (RMP)

Thermo-mech. (TMP)
Chemi-thermo (CMP, CTMP)
Semi-chemical (NSSC)

Low Fibre Yield
(Full Aspen Furnish)
Bleached kraft (BKP)

Paper/Paperboard
Products

Uncoated woodfree papers
Lightweight coated
Uncoated groundwoods
(Supercalendered grades)
Coated woodfrees

Solid bleached board
Tissue
Newsprint
Kraftliner
Corrugated medium

* based on previous studies.

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[1] See, for example, Market Assessment for Poplar Products. Prepared for the Governments of Canada, Alberta and British Columbia. Carroll-Hatch (International) Ltd. (July 1983) and Competitiveness of the Albertan vs. the U.S. Southeastern Forest Industry. Prepared for the Department of Economic Development and Energy and Natural Resources of the Province of Alberta. Jaakko Poyry (May, 1983).

The initial list of pulp, paper and paperboard options considered in this study is summarized in Table 5-1. High yield pulping processes refer to technologies which are relatively efficient in terms of fibre conversion. That is, most of the fibre input is recovered in the form of product. Typical fibre recovery rates from high yield pulps are in the order of 90 per cent. Low yield pulping processes, such as kraft which produces a very high quality product, typically involve fibre recovery rates of less than 50 per cent.[1] Fibre yield is only one of many variables to be considered when discussing pulp processes. Other variables include the quality and form of pulp produced. Moreover, the papers and paperboards made from these pulps are designed for a wide range of different markets.

Generally speaking, higher yield pulps are preferred, provided that they meet required quality standards for paper and paperboard making. This is not always the case, as will be discussed below. In the products in which they do meet quality standards, however, there are important financial and economic implications. Wood costs per unit of product can be kept lower than if a relatively inefficient fibre conversion process is used. Less timber is used to support the pulp mill. More pulp mills can be supported from a given area of timber and a given capital resource. These considerations are important for a region, such as northern Alberta, where a mix of forest industry development options is being evaluated.

Short-Listed Pulp Options[2]

Based on the evaluation of pulp and paper/paperboard product options carried out for this study, two pulp options have been shortlisted as having a potentially high rating for future investment consideration in northern Alberta. These are aspen bleached kraft pulp and bleached chemithermomechanical pulp (bleached CTMP). The latter is based on the assumption of a 50 per cent aspen furnish, the balance being spruce. All other pulping options have been evaluated as meriting a lower rating (Table 5-2) for potential investment consideration over the planning horizon of this study (1985-1994) under current market and economic assumptions.

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[1] Some additional fibre is "recovered" in the form of energy production through the combustion of black liquor.

[2] Based on either integration or partial integration with papermaking operations or as stand-alone market pulp operations. Specific details are discussed later.

Table 5-2

"Shortlisted" Pulp Options for Further Evaluation
(Integrated/Non-Integrated)

High Rating
- aspen bleached kraft
- chemi-thermomechanical (50% aspen)

Low Rating
- all others

Short-Listed Paper and Paperboard Options

Five papermaking options have also been shortlisted for further evaluation. These are: 1) uncoated woodfree papers; 2) uncoated groundwood papers; 3) light weight coated papers; 4) tissues (based on a mixed hardwood softwood furnish) and 5) newsprint (utilizing a maximum of 80 per cent aspen). All of the other possible major products identified in Table 5-1 have been evaluated as meriting a lower rating for potential investment consideration over the planning horizon of this study (1985-1994) under current market and economic assumptions.

Table 5-3

"Shortlisted" Paper and Paperboard Options for Further Evaluation
(Integrated)

- U/c woodfree papers
- U/c groundwood papers
- LWC
- Tissues
- Newsprint

Evaluation of Shortlisted Options

The shortlisted options are further evaluated below. The criteria for evaluation comprise:

a. Technical Feasibility

Is the process technically feasible in northern Alberta? This takes into account, in broad terms, the suitability and acceptability of northern Alberta's hardwoods and other technical factors such as whether or not the process is commercially proven. Another factor is whether or not Alberta has an already existing base of management expertise (or comparable expertise) in the technology. Throughout the analysis, reference is made to comparable areas where the process is already being used. Technical and related constraints are discussed, where relevant.

b. Economic Feasibility

Is the process economically feasible in northern Alberta? Based on published studies, and the best information available, this criterion has been used to determine a preliminary ranking of the economic feasibility of the various processes/products. Generally speaking, there is a very evident lack of published studies which would permit a thorough analysis of the economic potential for these investment options in northern Alberta. Economic feasibility for a region is not comparable to financial feasibility for a company and it is stressed that site specific studies would be essential prior to any investment commitment. The rankings of economic feasibility take into account very broad parameters of cost/revenue such as order-of-magnitude capital costs, probable operating costs, transportation costs, the need to import specific raw materials (e.g. kaolin for coated papers) and probable cost competitive position in export markets. These factors are discussed for each shortlisted product later in this section.

c. Market Outlook

The distinction between market outlook and economic feasibility is important. A product can have a very favourable market outlook (e.g. strong growth in demand) but may rank as a low priority for a specific region, such as northern Alberta, because of, for example, high transportation costs involved in getting the product to market. The market outlook is discussed at a general level for each shortlisted product later in this section.

A summary of the relative evaluations is provided in Table 5-4.

Table 5-4

Incremental or New Development Options in Pulp & Paper for Northern Alberta

Relative Rankings (1st Screening)

	High	Medium	Low Potential
Technically Feasible & Proven Process	Aspen Kraft	U/c woodfrees U/c groundwoods LWC Aspen/swd CTMP	Tissues (mixed hwd/swd) Aspen Newsprint (20% swd kraft)
Economic Feasibility	Aspen/swd CTMP	U/c groundwoods LWC	Aspen kraft Newsprint All others
Market Outlook	Aspen kraft LWC	Aspen/swd CTMP U/c groundwoods	All others

OPTION #1

ASPEN BLEACHED KRAFT PULP

Technical Feasibility

The potential for locating a mill in Alberta has been recognized for some time. Northern Alberta's aspen would produce a bleached kraft pulp which would be equivalent, in certain applications, to the highest quality bleached hardwood kraft pulps produced internationally.[1] Apart from these very high quality applications, northern Alberta's aspen would be at least as acceptable as most competing pulps in the production of almost any type of paper or paperboard.

Bleached hardwood kraft pulps are used in a wide variety of paper and paperboard products, especially where high strength is not a major requirement. Bleached hardwood kraft pulps find ready markets in printing papers and paperboards where a high degree of printability and opacity is required. They also are used extensively in tissues, diaper grades, solid bleached boards and many other products.

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[1] Carroll-Hatch (International) Ltd., ibid.

Bleached hardwoods are one of the fastest growing market pulps in world trade today. Supply has increased significantly in recent years as 'new' areas, such as Brazil, Portugal, South Africa and so on, have installed additional capacity. They also are used extensively as integrated pulps in papermaking (e.g. Nordic countries, Europe, the Eastern bloc, the U.S., Japan).

There are seven mills producing bleached hardwood kraft market pulp on a regular basis in Canada. In addition, two or three softwood kraft mills (including some in the west) produce some bleached hardwood kraft (e.g. Prince Albert Pulp, Saskatchewan). All are located in eastern Canada. From a technical management point of view, production of hardwood and softwood kraft pulps is very similar. Consequently, there is unlikely to be any significant technologically related constraints to bleached hardwood kraft production in northern Alberta. Small quantities of bleached hardwood kraft market pulp have been produced recently, on a trial basis, at Procter & Gamble's Grande Prairie, Alberta, kraft mill. **Aspen bleached kraft pulp rates high in terms of technical feasibility for northern Alberta.**

Economic Feasibility

The very high capital costs involved in a new greenfield bleached kraft pulp mill (around U.S.$400-500 million for an 800-1,000 tonnes per day mill) generally do not justify new capacity unless operating costs can be kept low. The main constraint is that product prices currently (and for the foreseeable future) do not provide an adequate rate of return on this level of investment. Also, the total investment is affected by the real cost of capital which seems likely to remain high for some time.

During the 1970's, changes in environmental regulations dictated the need for expensive pollution controls. Energy efficiency needs pushed up costs and inflation also had a strong impact. The rising economy of scale of new mills also increased capital investment. Consequently, bleached kraft mill capital costs experienced a quantum leap over the past decade, as illustrated in Figure 5-1.

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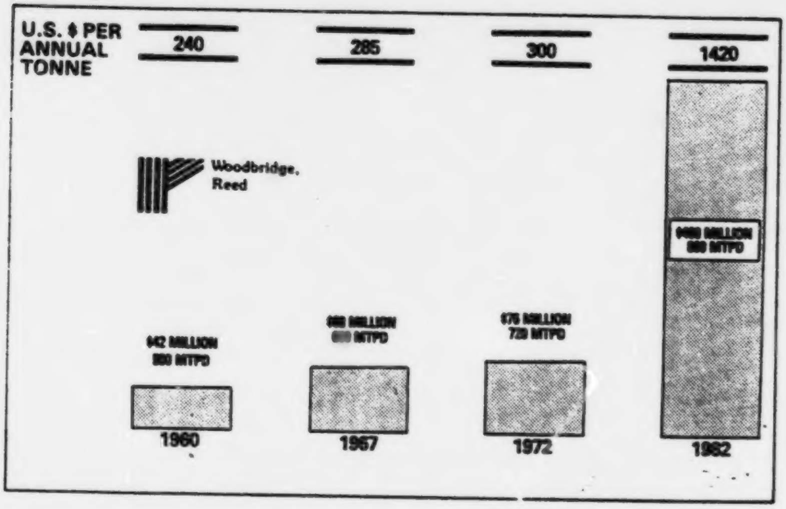
[1] Carroll-Hatch (International) Ltd., ibid.

Figure 5-1

Typical Capital Costs for Bleached Kraft Pulp Mills, Showing Rapid Rate of Cost Escalation within the Past Decade



Source: Woodbridge, Reed

Recent cost efficiencies in equipment supply and mill design indicate that the capital cost of a new greenfield bleached kraft mill to be located in Alberta could be lower than the estimates provided above. The kraft mill, earlier proposed by B.C. Forest Products for the Whitecourt, Alberta, area apparently involved a capital cost of C.$375 million. When investment costs are taken into account, the total cost of the project, in 1984 dollars, was estimated at C.$429 million.[1] At the level of detail provided (in the report[1]) it is not possible to evaluate the economic and financial feasibility more precisely. On a preliminary basis, **the potential economic feasibility of an aspen kraft mill for northern Alberta has been given a low rating.**

Market Feasibility

An aspen bleached kraft pulp mill located in northern Alberta probably would serve three broad geographical markets. These are:

1st The U.S. (particularly mid-west and western regions)
2nd Japan/S.E. Asia
3rd Domestic (mainly western Canada)

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[1] Impact on Alberta Economy Resulting From Continued Development of Berland Forest Management Area As Proposed. Bi-Community Committee (Fox Creek, Whitecourt) Report to the Government of Alberta (June 1984).

Low priority is given to market potential in Western Europe which traditionally has been a large market for Canadian hardwood market pulp. A producer in northern Alberta would face strong competition from other supplying regions to this market.

The principal market opportunity is the U.S. The 1983 Carroll-Hatch study[1] noted:

> "More promising markets would be in the U.S., particularly in the mid-west and western regions. Hardwood sulphate pulps are produced primarily in the U.S. northeast and southern regions, with only a relatively small amount in the mid-west. As in Canada, the western part of the U.S. does not have a local supply of market bleached hardwood pulp, and, therefore, markets for this pulp, based on aspen, could probably be developed in the aforementioned regions for most of the production from a new mill in Alberta or B.C. It has been established that aspen-based pulp can be as good or better than the standard North American mixed hardwood pulp for most applications. The U.S. imports substantial quantities of bleached sulphate hardwood pulp from Canada and, in recent years, also from Brazil. For example, in 1981, 55% of the total imports came from Canada and about 42% from Brazil.
>
> "It is conceivable that a supplier, located in Alberta or the B.C. Interior, could also allocate a part of its production for sale in Japan or other Asian markets (e.g. South Korea). In 1980, Japan imported 410,000 tonnes of bleached kraft hardwood pulp of which 48per cent came from Brazil, 30% from the U.S., 15% from Canada and the remaining 7% mainly from Scandinavia. It is noteworthy that all major suppliers, other than Canada and the U.S., are located farther from this market than would be a producer in B.C. or Alberta. Distance from the market is not, however, the only variable in freight structures. Other factors such as product density, availability and frequency of service from mill to market also affect transportation costs.

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[1] ibid., Volume 1.

> "In summary, the most promising markets for an aspen-based mill, located in either Alberta or B.C., appear to be the mid-western and western regions of the U.S. and, to a lesser degree, some Asian countries. The potential for developing pulp sales to those markets appears to be very strong since no significant market-related constraints appear to exist. If constraints do exist for aspen-based bleached kraft pulp, they would relate to production cost and could only be identified through a detailed technical/ economic study."

The market potential in the U.S. mid-west and western regions, noted in the study, nevertheless has to qualify to the extent that most of the growth is on an integrated basis and further work would be required to assess the potential for market pulp.

An additional market could develop domestically over the planning period as a result of a) integrated pulp/paper production in Alberta or b) demand for aspen hardwood kraft market pulp by the B.C. coastal industry, or both.

Aspen kraft market pulp ranks high in terms of market outlook.

OPTION #2

BLEACHED CTMP

Technical Feasibility

Although mechanical pulping (MP) processes are well established, CTMP is a comparatively new pulping process on a commercial scale. Most of the world's existing CTMP capacity involves softwood species. Aspen similar to that from Alberta is used to produce market mechanical pulp by the CTMP process at Rockhammars Bruk, Sweden. This is the only market mechanical pulp containing aspen or any other hardwood. Nevertheless, the level of R & D on aspen CTMP has increased substantially in recent years[1] and it is reported that an aspen/spruce market bleached CTMP mill is currently under active consideration for the Taylor area in B.C. Other market CTMP mills are being considered in Canada and elsewhere.

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[1] See, for example, 1) CTMP and CMP from North American Aspen (Populus tremuloides). Jackson, M. et al. Sunds Defibrator (1983); 2) Production of CTMP from Aspen, Universite du Quebec (1984); and 3) Market Mechanical and Chemi-Mechanical Pulp: A Growth Opportunity for Canada. Woodbridge, Reed and Associates Ltd. (1982).

Bleached CTMP from softwoods are accepted for use in high quality products in Scandinavia both on an integrated and non-integrated basis. Sweden's Oestrand mill produces a market pulp for use in fluff products (diapers) and towelling. Their towelling grade is preferred over chemical pulp. Folla Bruk in Norway recently started up a 200 tpd bleached CTMP mill and will be supplying the same grades as Oestrand. Billeruds in Sweden produces CTMP for solid bleached board and is now the leading supplier for Tetra Pak; probably the most demanding user in the world. Billeruds is also successfully producing a machine dried fluff CTMP from spruce.

Quesnel River Pulp in B.C. produces high freeness softwood grades which are accepted in towelling. While market response of Quesnel River's CTMP has been guarded, indications are that this mill has been operating at or near capacity.

The main limitation for the high freeness bleached CTMP from softwood has been for use in high quality tissues. The high stiffness of the softwood fibres results in poor surface softness. Laboratory studies indicate that aspen may be acceptable in these grades although little commercial data is available.

Aspen's greatest potential is in low freeness printing and writing grades. Since Rockhammars, the only producer of aspen CTMP, is a relatively small mill it is difficult to get a good appreciation of market acceptance. However, Rockhammars have been sold out for the past three years and are planning a modest expansion.

The major limitations of CTMP for high quality papers are brightness, brightness reversion and colours. Some of these limitations are real and some are perceived - the latter being based on the shortcomings of previous grades of market mechanical pulp. For the majority of commodity papers there should be no significant problem using a bleached aspen/spruce CTMP.

Because of the inherent riskiness of such comparatively new processes, **aspen/spruce CTMP has been rated as moderate to high in terms of technical feasibilility.**

Economic Feasibility

From an economic viewpoint, the CTMP process is very attractive. The capital required for an economically sized CTMP market pulp mill is about half of that required for a greenfield newsprint mill and about 25 per cent of that needed for a BKP mill. The fibre required is considerably less than for BKP and there are far fewer infrastructural and pollution problems, in most cases. The pulps produced are not directly comparable for all end uses. Yet, for a wide range of uses there is a potentially high rate of substitution of lower cost CTMP pulps for the more expensive kraft pulps. Moreover, the return on investment with CTMP is considerably considerably higher.[1] It is important to note that CTMP market pulp is considerably more demanding in terms of its marketing requirements than kraft pulp. Typically, CTMP pulps are tailor-made for specific end-uses.

An additional economic aspect of CTMP is its significantly smaller wood requirement compared with kraft. This means that in many cases, a CTMP mill can be located in areas which may not have sufficient fibre to support a kraft mill. However, CTMP is less tolerant of decay, as discussed earlier in Section 4.0.[2] **Bleached CTMP ranks high in terms of potential economic feasibility for northern Alberta.**

Market Outlook

The CTMP process has evolved over the last ten years from the laboratory stage to commercial production. Various companies have developed and are developing processes based on this technology. One such process has been developed by Sunds, a subsidiary of SCA, and is the process used by most CTMP plants now in operation. Two integrated Canadian paper manufacturers have developed, for their own use, processes to produce pulp similar to CTMP. Worldwide, there are a total of 13 CTMP mills, including two in Canada, using Sunds processes, most of which have been built in the last three years. Of the two mills in Canada, one is located in Quesnel River, British Columbia, and has been in operation since 1981 and the other is located in Bathurst, New Brunswick, and has been in operation since 1983. CTMP in general is used in conjunction with other fibre sources as a substitute for high quality chemical pulps such as kraft. The product characteristics of bleached CTMP are such that it has the potential to replace up to 50 per cent of the kraft pulp used in a significant number of end products. In specific products such as disposable diapers and towelling, the replacement potential is much higher.

It is estimated that total worldwide production capacity of CTMP has grown from virtually nothing in the late 1970's to approximately 1.4 million tonnes per year currently. Of this total production capacity, approximately 500,000 tonnes is market pulp, of which approximately 250,000 tonnes is bleached. This current estimated annual capacity of market bleached CTMP represents approximately 1.5 per cent of the total capacity of market kraft pulps which is estimated to be approximately 15 million tonnes per year.

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[1] See Market Mechanical and Chemi-Mechanical Pulp: A Growth Opportunity for Canada. Ibid.

[2] See also Bleached CTMP from Decayed and Stained Aspen Logs. Prepared for Alberta Research Council by Woodbridge, Reed and Associates, Econotech Services Ltd. and W.R. Dempster and Associates Ltd. (July 1983).

Because of the ability of bleached CTMP to partly replace kraft pulp and the rapid growth in demand for bleached CTMP in Europe, there is a large market potential for bleached CTMP in North America. Commercial production of bleached CTMP began approximately four years ago in Scandinavia and during that time its qualities have been demonstrated, primarily in Europe. Currently, the limited availability of market bleached CTMP outside Europe has prevented its widespread marketing in North America. A critical factor in market acceptance of bleached CTMP, as is the case for any new pulp, is user confidence in the product. This is achieved primarily through laboratory and production tests at customers' facilities.

Bleached CTMP has certain technical characteristics such as absorbency, bulk, softness and opacity which are superior or equal to kraft pulps. However, bleached CTMP has slightly lower strength and brightness than kraft pulps. The obvious applications of bleached CTMP are for products such as towelling, hygienic products, tissue and paperboard where the advantages of bleached CTMP over kraft pulps are more significant than its disadvantages. In addition to the technical characteristics noted above, the lower selling price of bleached CTMP is a major advantage and is one of the primary reasons for its anticipated success in penetrating those markets. The lower selling price of bleached CTMP is made possible by its substantially lower production costs due to the much lower wood and capital costs. Wood costs are significantly lower since the bleached CTMP process consumes only 40 to 50 per cent as much wood as the kraft process, per tonne of pulp. Lower capital costs are a result of the relative simplicity of the bleached CTMP process compared to the kraft process.

Bleached CTMP ranks moderate to high in terms of market outlook.

OPTION #3

UNCOATED (U/C) WOODFREE PAPERS

Technical Feasibility

A recent study[1] noted that the good quality of softwood kraft pulps which are produced in Alberta, and the quality of bleached aspen kraft which could be produced in the province[2] could be utilized in woodfree printing and writing papers. For the Athabasca area (which has limited availability of incremental softwood fibre) woodfree printing and writing papers were evaluated as having a high rating for future development of the hardwood dominated forest resources in the area.

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[1] Competitiveness of the Albertan vs. the U.S. Southeastern Forest Industry. Jaakko Poyry (ibid.) Volume 1, Page 3.

[2] Specifically, the Athabasca area.

The incremental softwood/hardwood fibre supply availability in various areas of northern Alberta varies in most instances from the Athabasca case. In some cases, there may not be the same level of softwood limitation. Delivered supply costs nevertheless would be an important consideration in the evaluation of the feasibility of a new greenfield pulp and paper installation in these locations. In areas of northern Alberta where there is a similar softwood supply limitation to that in the Athabasca area, the conclusions pertaining to the technical viability of woodfree printing and writing paper production would be essentially the same as in the Athabasca case.

> "Usually the furnish of these woodfree papers contains 20-50% bleached softwood pulp and 50-80% bleached hardwood pulp. the trend towards a high proportion of hardwood pulp has been very clear in recent years, and in new integrated mills this is often 70 to 85%. Hardwood pulps are used because they improve paper formation and optical properties, and lower the paper price. Softwood fibres are used more or less as reinforcement pulp to give the furnish better processability and the paper sufficient tearing resistance. In some grades bleached mechanical pulp is also used in amounts less than 10%. The grammage varies for paper grades from 50 to 150 g/m^2, and for board grades up to 250 g/m^2."
>
> "In principle the coarse-fibre southern pulps with good strength potential should allow a greater proportion of hardwood pulp or filler to be used in the furnish. However, experience has shown that the amount of long-fibre pulp should preferably be higher with southern pine pulps, which might be because the paper mills do not know how to beat southern pulps in the optimum way. At present, bleached kraft pulps from the U.S. South are considered to be of lower quality for the production of woodfree printing and writing papers than for example eastern Canada pulps."
>
> "Because of the high proportion, 50 to 80%, of hardwood pulp in these woodfree papers, the properties of the hardwood pulp have a great effect on the quality of the paper. The shorter fibre of aspen pulp gives better formation in woodfree printing and writing papers than hardwood pulp produced in the U.S. south (specifically Alabama). The finer fibres in aspen pulp would also give better opacity and better smoothness to the paper. On the other hand, the strength of the paper would be a little lower with the same proportion of softwood pulp. On the whole, woodfree printing and writing papers made from aspen pulp would have a quality advantage over those manufactured from hardwood pulp from Alabama."

The overall conclusion is that **woodfree printing and writing papers, from a technical viewpoint, rate as a high priority for development in northern Alberta.** This conclusion, however, is not supported at the present time on the basis of the economic and market evaluation criteria.

Economic Feasibility

Two recent studies have addressed the question of the economic feasibility of woodfree printing and writing paper production in Alberta.[1] Both studies are at a broad level and, in one case, the feasibility assessment involves a mill complex (i.e. including a sawmill) rather than a stand-alone mill. It is difficult, on the basis of the very general studies carried out to date, to arrive at anything more than a very preliminary assessment of economic viability. The Jaakko Poyry study concluded that a 357,000 tonnes/annum integrated woodfree paper mill, associated with an economy of scale softwood lumber mill, would be economically viable. The Woodbridge, Reed study, on the other hand, was less optimistic. The following points, extracted from the report[2], involve conclusions relating to both the economic and the market evaluations:

> "In uncoated woodfree papers, relatively strong market growth is forecast over the balance of the 1980's and into the 1990's. Nevertheless, as discussed earlier there are two principal drawbacks to this product segment:
>
> 1) The range of grades is very extensive (an Alberta-based mill like any other commodity grade mill at economy of scale, would have to concentrate on a limited range of grades).
>
> 2) Installed and announced new capacity currently is growing at a relatively fast rate in North America. Moreover, this is characterized by new capacity at large, very cost efficient, state-of-the-art integrated mills particularly in the U.S. South."
>
> "An additional drawback, identified earlier, is the comparatively high capital cost of a greenfield hardwood bleached kraft mill in Alberta and the relatively low rate of return on investment associated with it. Bleached hardwood kraft pulping would build on one of Alberta's strengths (suitable and low cost hardwood resources) but would not maximize its other comparative strength (low cost purchased power vs. the U.S.)."

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[1] Jaakko Poyry, ibid. and Woodbridge, Reed and Associates Ltd., ibid.

[2] See Section 10.0 of the Report.

The conclusion arrived at with regard to northern Alberta is that insufficient data exists to properly assess the economic viability of an uncoated woodfree paper mill. At best, a stand-alone mill would appear to merit only an average ranking in terms of potential economic feasibility. Moreover, a combination of other factors (such as the lack of external economies) would give it a low rating.

Market Outlook

In contrast to u/c and coated groundwood papers, which are mainly used for advertising-related purposes, u/c woodfree paper find their major markets as copy papers; in computer forms; in commercial printing; and in a variety of converting uses. U/C woodfree papers account for the largest segment of printing and writing paper consumption in all countries. In the U.S., for every tonne of u/c groundwood papers used, about 3½ tonnes of coated papers and over 5.5 tonnes of u/c woodfree grades are consumed.

The u/c woodfree paper sector globally currently is undergoing some interesting structural changes. In the U.S., some non-integrated capacity exists (about 21 per cent of total capacity in this grade in 1980). However, large new integrated machines in the U.S., particularly in commodity grades, pose a very strong competitive threat to many of the non-integrated or partially integrated producers of these grades both in domestic and, potentially in offshore markets. These latter mills purchase all, or a significant part of their pulp requirements on an open market basis.

The situation is even more dramatic in Western Europe where considerable over-capacity exists and only about 1 in 3 mills is integrated. Uncoated woodfree paper prices are closely tied to increases in pulp prices. While non-integrated and partially integrated mills have the flexibility to use various hardwood/softwood pulps, they are more susceptible to any sharp increases in pulp prices. As noted in the discussion elsewhere in this study, Sweden has installed a large amount of integrated u/c woodfree capacity within the last decade, targetted for sale in the EEC.

Demand for u/c woodfree grades has been strong in most major markets of the developed world over the past ten years - particularly in photocopying and computer form uses associated with growth in office and external communications. In the U.S., (where demand growth has been faster than in the EEC) these markets together with converting uses (stationery, envelopes, etc.) account for about two-thirds of u/c woodfree paper consumption. Significantly, virtually no other major grades compete in these markets. There are, nevertheless, some impending changes in this situation. The so-called "electronic office revolution" is likely to have an increasing impact on overall market growth. Secondly, the development of mixed-furnish paper grades, which do not have the necessary quality characteristics to displace u/c woodfree grades in the higher quality end of the office paper and commercial printing market, nevertheless could become more widely used in the middle to lower end of the range of uses dominated by u/c woodfrees.

It appears likely that the structural changes in the u/c woodfree paper industry in the U.S. will dominate market share and price behaviour in the mid to late 1980's. Namely, because of a) capacity growth in the U.S. South, b) larger machine sizes in commodity grades and c) closure, conversion or, potentially, relative low average operating rates in those smaller mills which continue to fight for market share in commodity grades.

The market outlook for this paper grade produced at a mill in northern Alberta is not promising. the market will remain very competitive for the foreseeable future. Consequently, **uncoated freesheet papers have been evaluated as having a low priority, based on market criteria, as a development prospect for northern Alberta.**

OPTION #4

UNCOATED (U/C) GROUNDWOOD PAPERS

Technical Feasibility

U/c groundwood papers are communication papers produced from mechanical pulps. Very broadly, they are made in a similar process to that used for newsprint. U/c groundwood papers comprise a wide grouping of grades, ranging from improved newsprint, at the lower end of the value-added range, to higher priced supercalendered grades which compete with LWC (see separate section). The spectrum of end-uses of u/c groundwood papers includes the following:

- telephone directory
- weekend magazines and Sunday supplements
- catalogues (mail order retailers)
- consumer magazines (e.g. T.V. Guide)
- advertising inserts (roto-news and high brightness offset and heatset offset)
- commercial printing
- book publishing (e.g. pocket books)
- business forms (continuous and non-continuous)

In 1982, about 55 per cent of uncoated groundwood papers consumption in the U.S. was for a wide range of advertising related publications. These included consumer magazines, some Sunday supplements (supercalendered grades: this market is also served by LWC), newspaper advertising inserts, catalogs and directories. The business forms market, comprising continuous and non-continuous office machine papers, accounted for further 18 per cent of total consumption. The other major end-use category, commercial printing, absorbed a further 14 per cent.

Supercalendered (S/C) Grades

Supercalendered grades are used principally for high quality gravure printing, but also include some offset and specialties. Fill content can be as high as 25 per cent (usually 10-25 per cent) compared with 3 per cent for other u/c groundwood papers. The mechanical fibre content, correspondingly, is lower (50-65 per cent) because increased fully bleached softwood kraft pulp is needed for strength. Freeness levels generally are lower than with other u/c groundwood papers.

The main uses, in the U.S., are for magazines (about 50 per cent of usage: but S/C competes with LWC), higher quality catalogs for mail order retailers (30 per cent) and inserts, commercial printing and direct mail (20 per cent). In comparison, sc papers which are well established in Europe are used more extensively in magazines than in other uses. European S/C grades are considerably higher quality than those produced in Canada.

At present, almost all u/c groundwood papers produced in North America use softwoods and are based on stone groundwood mechanical pulp technology. The use of TMP, which was introduced into printing papers in the 1970's, was associated with surface strength problems when used with low viscosity inks. The long fibre fraction of TMP is relatively stiff and causes linting problems.

Newer pulps, such as brightened or bleached CTMP, offer desirable higher brightness levels and some reduced stiffness of the long fibres together with improvements in bonding (softwood CTMP still problem). Increased use of CTMP is expected in these papers in the future. The Abitibi-Price Beaupre mill uses bleached CTMP for groundwood specialties.

Although technically possible for production in northern Alberta, this product option would depend largely on softwood fibre availability. The scope for using aspen is limited and the technological base (i.e. existence of an established newsprint industry) does not exist which would provide external economies. Consequently, u/c groundwoods merit only a moderate rating from the viewpoint of technical feasibility for northern Alberta.

Economic Feasibility

Northern Alberta meets some of the economic requirements for u/c groundwood paper production, but is weak in others. Fibre supply, fibre costs, energy availability and costs appear to be competitive. Production of these grades, however, would require sizeable investment in a greenfield plant. In contrast, there is considerable scope for production of these grades at existing newsprint mills in eastern and western Canada. Moreover, these mills already are established in mechanical paper production and could switch over their slower, less competitive standard grade newsprint machines to u/c groundwood production at comparatively lower cost.

In North America as a whole, a sizeable amount of standard grade newsprint capacity has been retired, or is planned for retirement or conversion upgrading to other grades, such as u/c groundwood papers.

Although there is potential for investment in a greenfield mill to produce high quality u/c groundwood grades (e.g. supercalendered) the economic feasibility of this option for northern Alberta is uncertain. **This option has been given a moderate rating on a preliminary assessment of economic feasibility.**

Market Outlook

U.S. consumption of u/c groundwood papers recently (1976-83) has grown at a high average rate (3.6 per cent/annum) and consumption per billion dollars GNP is increasing.

In Europe, however, there is strong competition amongst the large number of suppliers of this grade. Overall consumption levels tend to be higher (Europeans use more non-newsprint mechanical pulp based papers) than in North America. Market growth in Europe has been slower and is well served by Scandinavians (particularly Finnish) suppliers. The availability of higher quality grades at a competitive price also is very high in Europe.

Opportunities exist for further market growth in the higher value-added grades in North America. However, northern Alberta would be faced with strong competition from existing newsprint producers in other parts of Canada, which are generally closer, in terms of transportation distance, to the large consuming markets.

This product opportunity should not be ruled out. In the past few months, for example, a greenfield standard grade newsprint mill project has been announced for northern Washington (northeast of Spokane) and is aimed to serve the growing western North American market. Longer term demand growth in u/c groundwood papers is expected in western North America. **From a market viewpoint, this product option merits a moderate to high rating for longer term development in northern Alberta.**

OPTION #5

LIGHTWEIGHT COATED PAPER

Alberta is believed to have been considered relatively recently as a possible site for lightweight coated paper (LWC) production by a large U.S. producer (St. Regis).[1] LWC is used extensively for magazine printing (e.g. MacLeans); catalogs (e.g. Sears) and general advertising. In terms of tonnage this grade accounts for about half of total U.S. coated paper consumption. LWC is made from mechanical and chemical pulps. Typical furnishes are 50-55 per cent mechanical pulp and 45-50 per cent kraft pulp to add tearing strength, carry flows and to maintain paper machine and press runnability. The mechanical pulp furnish comprises mainly softwoods but up to 50 per cent aspen (i.e. 25 per cent of the overall furnish) is sometimes used. The St. Regis' Sartell, Minnesota, mill has a new LWC machine utilizing spruce, balsam fir residuals and aspen (roundwood) from RMP to produce a 56 g/m^2 paper, and Blandin at Grand Rapids, Minnesota, uses aspen. Short fibred kraft pulps, such as aspen are not used in this paper grade.

Stone groundwood has higher opacity than TMP but some LWC mills (e.g. Weyerhaeuser's Columbus, Missouri, mill) use TMP because of its greater strength which allows for reduced chemical pulp content and supplements the lower tensile strength properties of the southern softwood kraft pulps.

Despite the technological and economic trends favouring the advance of mechanical pulps in coated papers, the quality of the basesheet determines the overall quality of the final product. Good quality LWC, for example, can only be made with a very good basesheet, and this can be done only by paying close attention to the quality of the mechanical pulps.

From a technical viewpoint, northern Alberta's fibre availability and quality distribution are very suitable for LWC production. Good quality softwood krafts are already made in Alberta. Production of LWC would require, however, expertise in mechanical pulp production which does not exist at present in Alberta (e.g. there is no capacity in newsprint which would lend itself readily to the development of skills in LWC production). As investment in LWC is likely to involve a firm from out of the province, and presumably one with existing expertise in LWC production, this may not be a disadvantage. Nevertheless, many of the technical external economies which would facilitate such an investment do not exist in northern Alberta. **Consequently, production of LWC in northern Alberta provisionally has been given 'moderate' rating, rather than 'high'.**

Economic Feasibility

The studies[1] which have addressed the issue of the economic viability of LWC production in Alberta have indicated that, at a very broad level, this development option could be feasible. However, no site specific or feasibility level data are available to confirm or dispute these broad indications.

Alberta would appear to be very cost competitive in wood and energy; to be neutrally competitive in transportation costs to the probable markets identified; but to have higher costs with regard to other cost factors such as clays (for coatings) which would have to be imported. Transportation costs are an important consideration and the less favourable geographical position of a paper mill in Alberta appears to have been regarded in the past as a potential deterrent to such an investment. Alberta certainly does not have the locational advantages or the developed infrastructure and variety of shipping modes of some areas. But, on the basis of a preliminary analysis, estimated rail transportation costs to the Los Angeles area, for example, appear to be reasonably competitive with those of the U.S. South. Table 5-5 summarizes the quoted rail transportation costs for LWC paper from three possible supply locations to two major market areas.

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[1] Jaakko Poyry ibid and Woodbridge, Reed and Associates Ltd.

Table 5-5

1983 Estimated (Rail) Transportation Costs[1] (Preliminary only)
LWC (C$/tonne)

To:	Quebec[2]	Alberta[3]	U.S. South[4/5]
New York	56.45	132.25	63.70
Los Angeles	161.15	134.50	129.20

1 Based on rail shippers quoted rates: subject to negotiations. Excludes alternative or combination shipping modes (e.g. rail-water).
2 Montreal
3 Edmonton
4 Mobile
5 Rail only

The data indicate that an Alberta based LWC mill would be at a comparative transportation cost disadvantage to producers in the U.S. South and Quebec in shipments to the New York area: however, to the California market, rail transportation costs per tonne from Alberta appear to be reasonably comparable to those of the U.S. South, and lower than those from Quebec.

In any detailed feasibility study of a site specific mill location in Alberta further analysis of transportation costs would be essential. It should be noted that large printing paper mills in the U.S. Mid-west currently are suppliers to western U.S. and Canadian markets and are well served in terms of transportation infrastructure. Also, the estimated costs shown in the table have been subject to direct negotiation since de-regulation and, from some seaboard locations (e.g. the B.C. Coast), alternative transportation modes exist. **Although there is a lack of specific data, it appears that LWC paper would merit a moderate to high rating in terms of potential economic feasibility for northern Alberta.**

Market Outlook

This paper grade is one of the most exciting at the present time from the point of view of a) rapid market growth and b) real price increases.

An LWC mill based in Alberta would represent a useful form of functional integration with the province's already established market softwood kraft pulp facilities. The potential for capturing a high proportion of the western Canadian market, and the potential for exports to other parts of the western North American market (including some share of the Californian market), appear very favourable.

Currently, there are no producers of LWC paper in western Canada and merchants report that supply from eastern Canadian mills is sporadic (western merchants are penalized, for example, when LWC paper goes on allocation as has happened due to tight supply conditions at times in the past five years).

Consequently, the preliminary market outlook rating for a greenfield LWC paper mill in Alberta, at economy of scale, is very high.

OPTION #6

TISSUES

Technical Feasibility

In northern Alberta, the fibre base exists for production of tissues (mixed hardwoods/softwoods). By virtue of the high bulk of most products, international trade in tissue products is limited. Future growth in overall production, consequently, is tied to domestic consumption and the limited growth which is expected will depend largely on demographic factors and further success of market extension efforts. Expansion of demand in some market segments is expected to be offset by declines in others.

Nearly all tissue is shipped as consumer tissue (facial, towel, toilet) for resale. Commercial and industrial tissues account for a comparatively small additional volume. Disposable diapers and "super-absorbent" consumer products (the latter based on highly absorbent polymers) are made by some tissue producers, but this is not considered part of the tissue business.

As far as North America and Europe (and Japan in some grades) are concerned, the higher value tissues have reached their practical peak in quality improvements. Diminishing marginal returns have set in as far as further quality improvements are concerned. Consumers have been induced to spend more, in the past, on perceived quality improvements. Some of these have been more apparent than real. Driven by a strong marketing orientation, process technique improvements (such as 'through-drying') have maximized the bulk characteristics of many tissue products, but have lowered the sheet count. In other words, consumers receive possibly a better product, but less fibre for the same, or higher, real cost.

In contrast, reduced basis weights in printing and writing papers have not resulted in a reduction of sheet area, and so consumers or converters generally have received "as much" at a lower real cost.

In high grade tissue, the production goal now is towards equivalent quality at lower cost. Essentially, this requires a switch to lower cost furnish components. Specifically, replacement of softwood kraft with pulp substitutes high grade secondary fibres, such as white clippings and shavings of uncoated grades) and, where feasible, lower cost virgin pulps. Pulp substitutes have been the first preference and these are attractive to tissue makers because of their comparatively low cost. Pulp substitute supply, however, ultimately is limited and a significant proportion increasingly is captive. Tissue makers increasingly have turned their attention to high quality, mechanical pulps.

Although technically speaking, the mix of uncommitted virgin fibre species in northern Alberta could support a tissue mill, the area does not have an adequate source of secondary fibre. Moreover, the technological base (e.g. existence of mechanical pulping facilities/expertise) is weak. Consequently, this product option is given a low rating from the viewpoint of technical feasibility.

Economic Feasibility

The major economic drawbacks for production of tissues in northern Alberta include 1) lack of regional markets of any size and 2) the high cost of transportation to the export markets which do exist. In addition, it is doubtful that a plant located in northern Alberta could be a cost competitive producer. This product option is given a low rating in terms of economic feasibility.

Market Outlook

On a worldwide basis, demand for tissues is expected to be fairly strong in comparison with lower value papers and paperboards. Much of the volume growth, however, is expected to take place in less-developed countries. Consumption trends in North America and Europe indicate that market saturation has occurred, or soon is likely to occur, in major segments of this industry, such as facials, toilet and towel. There are some growth items in these markets. In Japan, per capita consumption in household tissue paper still is less than 50 per cent of the U.S. level and, in items such as towels and napkins, a shift in cultural factors could result in fairly fast growth in consumption.

Per capita consumption of tissue in the U.S. rose rapidly along with rising standards of living in the 1960's, but slowed considerably during the 1970's. The very high consumption (of around 18 kg./capita) attained by the late 1970's had resutled from strong marketing efforts, increasingly high product quality and the launching of succeeding generations of 'new' or 'improved' products. Nevertheless, in most segments, opportunities for market-extension i.e. development of increased consumption of a product through strong marketing efforts) became more limited and saturation levels, more or less, have already been reached.

European consumption patterns differ, however, from those of North America. The U.S., as the leader in tissue (and super-absorbent product) technologies, has set the pace in the past. In the early 1970's, consumer marketing and consumption in, for example, toilet tissues were characterized by considerable emphasis on strength. The U.S. industry (which has a presence in Europe) emphasizes softness. By the end of the strong growth in the 1970's, a number of the EEC countries had essentially completely converted to soft tissue. However, in soft tissues there is scope for further per capita increases in markets such as the U.K.

The benefits to northern Alberta (based on potential synergies with its existing business) appear to be limited. Consequently, tissues are given a low rating as a potential investment, from a market viewpoint, for northern Alberta.

OPTION #7

ASPEN NEWSPRINT

Technical Feasibility

Although newsprint is normally made from softwoods, northern Alberta's aspen technically could be utilized. Aspen CTMP was used as the major furnish component for newsprint in a recent pilot trial at the SCA Matfors mill in Sweden, together with 15 per cent semi-bleached kraft for strength. A comparison of the results showed that there were no serious quality differences between the newsprint produced and typical Swedish standard newsprint.[1] In addition, aspen newsprint has been made on an experimental basis at the Prince Albert Pulp mill in Saskatchewan.

Some of the trial newsprint rolls in the Swedish trial were printed in a local offset pressroom. No difficulties were experienced in printing the local paper and the printers were unable to identify any significant differences in printing properties between the trial newsprint containing 85 per cent aspen CTMP and standard newsprint. Additional printing trials were conducted in two North American pressrooms with similar response.

In newsprint, aspen decay levels are not critical to opacity, but high levels do have an adverse impact on brightness of the sheet. Moreover, the use of aspen requires the use of a minimum of 15-20 per cent of the more expensive chemical pulp for strength (see impact on economics below).

Newsprint made from softwood residuals was considered by BCFP for a site at Hurdy, Alberta, but this proposed project subsequently was cancelled. At present, Alberta does not have any local expertise in newsprint production. It would be possible to acquire much of the management expertise from an out-of-province investment (such as by BCFP). But there is a lack of external economies (including factors such as specifically trained local labour) at the present time. The prospects for an aspen based newsprint mill in northern Alberta, based on technical feasibility, are considered to be low for the foreseeable future.

Economic Feasibility

The economic feasibility of aspen newsprint cannot be determined from the published data available for this study. Northern Alberta's aspen resource would appear to be competitive in terms of delivered cost of fibre to the pulp mill, but, as noted earlier, would require the inclusion of 15-20 per cent chemical pulp to give the newsprint the required strength for runnability on the paper machine and in the pressroom. Purchased energy costs are lower than in the U.S. However, there are many other cost and competitive factors which would have to be taken into account.

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[1] CTMP and CMP From North American Aspen, CPPA 1983). Jackson, M., Sunds Defibrator Canada: Gorgen Akerlund, Sunds Defibrator, Sweden and Hans Hoglund, SCA Development.

Aspen newsprint could be shown in the future to be economically feasible for northern Alberta but current trends are in favour of softwood newsprint made from 100 per cent TMP. Most western Canadian producers (Crown Forest, BCFP and MacMillan Bloedel) use a proportion of semi-bleached kraft for strength but, in other areas, the trend favours elimination of this higher cost chemical component. **The probable economic feasibility of aspen newsprint produced in northern Alberta is regarded as being low, for the foreseeable future.**

Market Outlook

Almost all areas of the world consume some newsprint. Newsprint represents the largest amount of any single paper or paperboard grade produced in the world. Taking, for example, the pre-recession year of 1981, global production of newsprint was 26.7 million tonnes or about 15.6 per cent of the world's paper and paperboard production.

Canada has the largest share of global newsprint capacity, and about twice as much as the U.S. which is the second largest producer. During the 1970's and early 1980's, Canada averaged 35.4 per cent of the world's newsprint capacity (these data include some uncoated groundwood papers, particularly roto-news in the late 1970's). In comparison, the U.S. averaged 14.9 per cent. Scandinavia and Japan also are significant producers of newsprint.

The growth of world newsprint capacity was fairly consistent during the period 1970 to 1983 (Figure -) with the exception of 1973/74. This break in the curve was due to a revision in the capacity of a significant number of newsprint machines in changing from 52.1 g/m^2 to 48.8 g/m^2 (32 lb./3,000 ft.^{2} to 30 lb./3,000 ft.^{2}) newsprint. During the 1970's, newsprint production grew at an average annual rate of 2.3 per cent from 20.7 million tonnes in 1970 to 25.8 million tonnes by 1980. Production displayed a fairly progressive upward trend with the exceptions of 1975 and 1982 which were recessionary years for the world economy.

The world's supply and exports of newsprint are dominated by Canada (33 per cent of the world's production and 63 per cent of global exports in 1981). In its export role, Canada's principal competition is Scandinavia. In addition, Scandinavia's global export market share has been increasing - from 21 per cent in 1970 to 25 per cent in 1981. Canada, on the other hand, has been losing market share in its principal traditional markets.

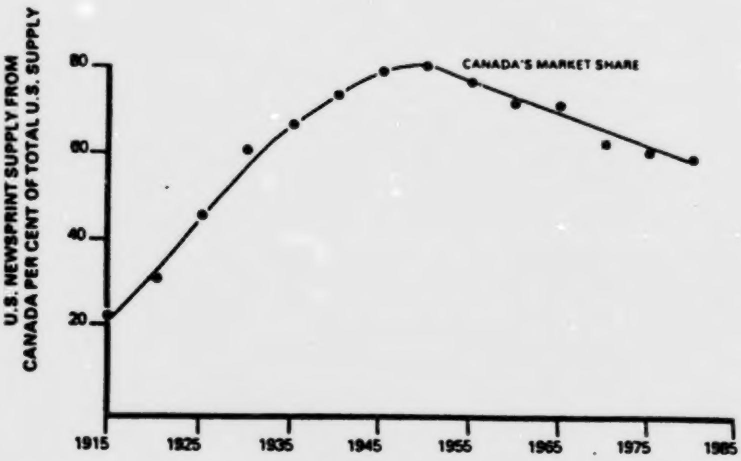
Apart from Canada and the Scandinavian countries, no other region or countries have been significant factors in newsprint exports. It is true that Japan increasingly is becoming an influence in Asia. But although Japan's exports are increasing, so too are its imports - an indication that Japan may simply be developing a role, in effect, as a distribution centre.

The U.S. consumed over 40 per cent of the world's newsprint from 1970 through 1983. U.S. demand for newsprint increased steadily from 1975 onwards except for 1975 when demand dropped to 10.6 million tonnes and, again, in 1982 when demand fell to less than 10.0 million tonnes. Nevertheless, U.S. newsprint consumption since the mid 1970's recession has been relatively strong - despite concerns over the potential displacement impact of newspapers by other media advertising forms (e.g. non-print media such as on-line video equipment in the home). Part of this is due to the development of new products by publishers and advertisers including newspapers inserts, flyers and the use of colour (e.g. 'U.S.A. Today'). Recent demand growth (and price recovery) has been stimulated by higher than expected advertising expenditures in newspapers.

On the other hand, Canada's share of the U.S. market (which increased from 1926, to reach 80.2 per cent of U.S. supply by 1950) has declined significantly since the mid 1970's. From 1978 to 1982, for example, Canada's share of the U.S. market declined from 65.9 per cent to 56.1 per cent (Figure 5-2). Moreover, this decline is still significant even when adjustments are made for cyclical variations.

Figure 5-2

U.S. NEWSPRINT SUPPLY



Source: CPPA

In the past, when Canadian supply dominated the U.S. newsprint market, Canada clearly had a very strong price leadership role. This control has been eroding and the shift towards Canada's new role as a marginal supplier became evident in the 1982 economic recession.

Between 1980 and 1983, North American newsprint capacity increased substantially. Even though Canadian newsprint capacity increased by 17 per cent, capacity in the U.S. increased by over 35 per cent. The increasing newsprint capacity in the southern U.S., and consequent increasing U.S. self-sufficiency, coincided with a decline in Canadian newsprint cost competitiveness.

The principal factors underlying Scandinavia's increased penetration of export markets, including Europe and, to a lesser extent the U.S., are 1) substantial newsprint capacity increases in the late 1970's and 2) the very sizeable devaluations which occurred in Scandinavian currencies, particularly Sweden's, in 1981 and again in 1982 in terms of U.S. funds (the basis of international pricing). Also, European producers have more readily accepted sales denoted in local currencies.

Between 1976 and 1978, Sweden installed or committed an increase in capacity of almost 400,000 tonnes per year and, in Norway's case, of close to 140,000 tonnes per year. The impact of these factors resulted in a strong surge in export competitiveness and volume from these two countries. A further factor affecting Canadian export market share in the EEC has been the pending imposition of reduced newsprint quotas for non-EEC/EFTA countries which include Canada. Longer term demand growth is expected to be reasonably strong globally, but competition among suppliers is likely to continue. **Aspen newsprint is given a moderate rating in terms of market feasibility for a northern Alberta based mill.**

CHAPTER SUMMARY

- Based on published data, and the consultants' experience and judgement, various pulp and paper development options utilizing hardwoods have been considered for northern Alberta.

- These options have been evaluated, on a stand alone basis, using three criteria. They are a) technical feasibility b) economic feasibility and c) market outlook. In most cases, the findings are preliminary but nevertheless are believed to be reasonably indicative of true development potential over the next decade. The results are summarized below:

Table 5-6

Preliminary Feasibility Assessments for Hardwood Based Pulp and Paper Options in Northern Alberta

#	Short-listed Options	Technical	Economic	Market
1	Aspen bleached kraft pulp	H	L	H
2	Bleached CTMP	M-H	H	M-H
3	Uncoated woodfree papers	H	L	L
4	Uncoated groundwood papers	M	M	M-H*
5	Lightweight coated paper	M	M-H	Very H
6	Tissues	L	L	L
7	Aspen newsprint	L	L	M

H = high M = moderate H = high * in longer term

- It is stressed that much additional work would have to be carried out to confirm the initial findings, and to identify other relevant factors.

- The short-listed pulp and paper development options are ranked in the table below in terms of most probable likelihood of success in northern Alberta.

Northern Alberta: Ranking of Hardwood Based Pulp & Paper Development Options*

Most Promising
Aspen/Softwood CTMP
Lightweight Coated Paper (LWC)
Bleached Aspen-Kraft Market Pulp

Longer Term Potential
Uncoated Groundwood Papers
Uncoated Woodfree Papers

Possible, But Not Given a High Ranking
Newsprint
Tissues

* Specialty pulp and paper products have not been considered.

6.0

WOOD PRODUCT OPTIONS (STAND ALONE)

The analytical approach in this section is similar to that of Section 5.0. The initial wood products considered are listed in Table 6-1. These are subsequently evaluated individually. The evaluation criteria are identical to those used in the previous section. Throughout the section, only 'stand-alone' wood product options are considered. That is, plants which could be considered independent of other forest product operations on the same site. Integrated wood product options (e.g. combined pulp/paper/wood product complexes) are discussed in Section 7.0.

Table 6-1

Wood Product Options Considered

Sawnwood	Composite Boards
Aspen Lumber	Waferboard/OSB
Aspen Lumber Specialties	Medium Density Fibreboard (MDF)
	Particleboard
	Construction Plywood
	Specialty Plywood

These options are evaluated in detail below.

OPTION #8

WAFERBOARD/OSB

Technical Feasibility

The necessary technology to build and operate a waferboard plant is already available in Alberta. Though oriented strand board is a relatively new development of the waferboard process, the technology is now proven and readily available to any new company in Alberta. The aspen resource, even with a significant proportion of decay, has proven an excellent raw material. Until recently, virtually all the waferboard plants in North America were based on aspen. There is some problem however with balsam poplar due to a much greater moisture content. At Slave Lake, the waferboard plant excludes this species. **The technical feasibility of waferboard/OSB in northern Alberta is rated as high.**

Economic Feasibility

Fibre and other material costs, such as resin and wax should be comparable with other producers. Similarly, actual manufacturing costs should be reasonably competitive. Due to the lack of existing infrastructure and climatic conditions, capital costs are likely to be higher than many of the new plants being built in the U.S. A very significant problem is the cost of transportation to the major markets. Waferboard/OSB is a relatively low value product and is heavy. Consequently freight can become a high proportion of delivered cost. For example, current delivered prices for waferboard in Toronto are around $200 per 1000 sq.ft. for 7/16" board. Transportation costs from Alberta would amount to $60 or 30 per cent of the delivered price. Thus though actual production costs would be favourable, the costs of transportation reduce the rating to medium/low. **The economic feasibility of this option is considered to be moderate to low.**

Market Outlook

The demand for waferboard has been growing very dramatically in recent years. Consumption in the U.S. has increased tenfold from 1974 to 1982. WRA estimates that consumption in 1984 could be close to 1.5 billion square feet 3/8" basis. This is around 10 per cent of structural panel consumption in the U.S. Even in Canada, where waferboard markets were developed some years ago, consumption has continued to increase and is now close to 20 per cent of structural panel use in construction.

The product is now being accepted by many builders as a substitute for plywood. Production costs are well below those of plywood since

- The product yield from raw material is greater. Close to 85 per cent yield is obtained as against only 35 per cent for plywood.
- Relatively cheap fibre can be used, whereas plywood production demands a superior quality of log.
- Actual manufacturing costs are lower since less labour is required.

It is highly probable therefore that consumption will continue to grow substantially as further substitution is achieved at the expense of plywood.

Future market potential in North America is therefore excellent but, unfortunately, the capacity to produce is also growing very rapidly. Canadian capacity is already far in excess of domestic demand. Much of this capacity was built with a view to exporting 50 per cent or more of production to the U.S. While U.S. capacity was limited, this was possible but in the last 18 months there have been many new plants established in the U.S. Current U.S. capacity, including plants under construction, is now close to 3 billion square feet 3/8" whereas in 1980 it was only 90 million. These plants are all closer to the markets than any Canadian facility and make it increasingly difficult for Canada to continue to export large volumes economically to the U.S.

Thus, though demand is strong the market outlook for incremental capacity located in northern Alberta must be regarded as poor. Some years earlier it had been believed that the California market could hold good potential but recently several plants have been built in the Western States with lower transportation costs.

These new facilities, combined with the two existing Alberta plants, would make it difficult for a further Alberta operation to compete.

This pessimistic outlook is based on a continuation of the current production and marketing approach adopted by the great majority of plants i.e. a low cost substitute for sheathing plywood. There is the possibility that a more innovative approach, whereby the flexibility of the process is utilized to produce higher value products for other specific markets, may broaden the market opportunity. However, though the need for this type of development was identified over two years ago, at the June 1982 Waferboard Symposium in Ottawa there have been few fundamental changes. **It is not appropriate at this stage therefore to allocate any better rating than 'low' to the market potential for a new facility in Alberta.**

OPTION #9

CONSTRUCTION PLYWOOD

Technical Feasibility

High quality aspen logs with a minimum of decay can be peeled. The technology has existed for many years. It should be noted however that poplar plywood production has been declining. The experience of Ziedler Forest Industries in the manufacture of poplar plywood has been such that the company no longer produces the product. The logs are difficult to peel due to the many defects common to the species. **The technical feasibility of this option is considered moderate.**

Economic Feasibility

The veneer yield from even selected logs is poor. Furthermore the use factor of the veneer that is produced is low due to defects such as splits, oversize knots, ring shake and so on. The moisture content of the green veneer is high compared with spruce therefore drying costs are higher. It is also necessary to use more glue in the plywood manufacture. Finally, the returns to be obtained for construction plywood manufactured from poplar tend to be lower than for other types of plywood.

The economics of production relative to competing products are therefore low for this option.

Market Outlook

The impact of waferboard on the construction plywood market has already been described. **The market outlook for a poplar construction plywood facility in northern Alberta must therefore be ranked as low.**

OPTION #10

MEDIUM DENSITY FIBREBOARD (MDF)

Technical Feasibility

Process technology is well established in North America and equipment manufacturers indicate that aspen fibre can be utilized to manufacture a good quality panel. The presence of some decay would not present any major technical problem. **This option is given a high rating in terms of technical feasibility.**

Economic Feasibility

The majority of existing North American producers utilize sawmill residue and chips. If the facility in Northern Alberta is to be based on roundwood it is likely that the cost of fibre into the mill will be high compared with competitors. It is also believed that the quantity of resin required may be somewhat greater for an aspen furnish.

The major problem, however, relates to the cost of transportation. The economies of scale of manufacture indicate that the minimum size of plant is around 50 million sq.ft. 3/4". The Western Canadian market potential for MDF is too small to absorb more than a relatively small percentage of this volume. Consequently, the product would have to be shipped a substantial distance in order to access sufficient market for the plant to operate at near capacity. Even though the product is of higher value than particleboard it is also heavier and, again, transportation costs would become a significant proportion of delivered costs. **The economic feasibility is rated as moderate to low.**

Market Outlook

The demand for MDF is likely to increase significantly in Canada and at a somewhat slower rate in the U.S. However, the principal reason for the increase in Canada will be the forthcoming availability of MDF from Canadian facilities. Alberta Energy Company is now building a new plant at Whitecourt using sawmill residue. It is believed that this company will be developing an aggressive marketing programme to develop outlets for its products. In addition it appears likely that a Quebec company, Rexfor, may establish a facility. The Canadian MDF market, even with a very substantial increase - say two to three times current consumption, will not be sufficient to absorb the production volumes of these plants. They will therefore be pursuing the U.S. and offshore markets. At the same time there is some increase in capacity occurring in the U.S. Furthermore there are new plants being built that will compete in the Far East markets.

Due to the substantial increases in capacity foreseen it is believed that the market outlook for further incremental capacity in Alberta must be rated as low.

OPTION #11

PARTICLEBOARD

There are essentially three grades of particleboard each of which compete in different market sectors. These are:

- **industrial particleboards:** essentially used in furniture, kitchen cabinets and sash, door and millwork sectors.
- **standard particleboard:** floor underlayment, shelving, mobile home decking and general DIY applications.
- **thin particleboard:** a lower cost substitute for hardboard and thin plywood principally imported from the Far East.

The situation relative to technology and production economics is reasonably common to all three types and can be discussed jointly. However the supply/demand and market outlook varies for each and needs separate analysis.

Technical Feasibility (All Grades)

Process technology is well established even for the newest product--thin particleboard. Aspen roundwood furnish is theoretically satisfactory but it should be noted that most facilities are based on softwood sawmill residue. Decay in the furnish would not be a critical factor though it could increase production costs. **The technical feasibility is high.**

Economic Feasibility (All Grades)

The costs of utilizing roundwood would be greater than sawmill residue. Resin requirements may tend to be higher. Unless a very small plant is built, much of the product would have to be shipped considerable distances to the markets, therefore transportation costs would tend to be high. **The economic feasibility of this option for northern Alberta is rated as moderate to low.**

Market Outlook (Each Grade Examined Separately)

Industrial Particleboard

Western Canadian markets for industrial particleboard are relatively small. Even though it appears likely that Parta Industries at Grand Forks is unlikely to reopen there is still substantial competition foreseen

- from the AEC MDF plant which will, inevitably, penetrate a significant proportion of the furniture and, possibly, millwork markets.

- from the MBL plant in Vancouver where there is increasing pressure to expand the proportion of industrial board produced due to the decline in demand for standard particleboard.

- from the particleboard plant at Smithers. Though this plant was originally designed to manufacture thin particleboard the markets for this product have not developed as expected and the current objective of management is to produce increasing volumes of industrial grades.

- U.S. producers such as Louisiana Pacific in Montana who consistently ship volumes to Canada, particularly of special sizes such as countertop substrate.

It is judged therefore that the market outlook for incremental production of this grade in northern Alberta rates as 'low'.

Standard Particleboard

The market for standard particleboard has been declining for a variety of reasons.

- the well publicized problems with urea formaldehyde
- the increasing replacement of mobile home decking with substitute products such as waferboard
- changes in building techniques

The outlook even for existing production capacity, is not favourable. **This grade is given a low rating.**

Thin Particleboard - Medium

The economics of thin particleboard are favourable relative to the products with which it competes--lauan plywood and hardboard. These products are utilized in a variety of market sectors.

- furniture (backs, drawer bottoms and so on)
- doorskins for flush door manufacture
- decorative wall panelling
- general retail

North American imports of lauan plywood are very large at around 1.5 billion sq.ft. per year. The supply outlook, however, is uncertain. Until recently much of this was produced in the Philippines and in Korea and Taiwan based on logs imported from Indonesia.

The Philippine resource availability for plywood production appears likely to decline unless there is greater acceptance of less known species. The Indonesian Government has adopted a policy of drastically limiting any log exports. Instead, a large number of plywood mills have been built. These appear to be significantly less efficient than the very sophisticated mills that were based in Korea and Taiwan. So far these changes do not appear to have caused any major disruptions in markets but there are increasing concerns about the long term outlook.

The hardboard outlook is also somewhat uncertain. No new facilities have been established in North America for some years. Increasing volumes are being imported from sources such as Mexicc and Brazil.

With the supply uncertainties in lauan plywood and the lack of new capacity for hardboard it would appear that the outlook for a competitive substitute product should be favourable. There are, however, two aspects that cast some doubt:

- the Smithers plant, referred to earlier, has had great difficulty in marketing thin board ever since it commenced production 3 years ago.
- door manufacturers have been reluctant to change to the use of thin particleboard for doorskins.
- public preferences and tastes in wall covering have been changing. This is a very large market with many diverse products competing at different levels--paint, wallpaper, 4'x8' sheets, solid wood and so on. Even within the 4x8 sheets the products range from printed particleboard retailing at $5 to $6 per sheet to overlaid lauan plywood at $10 to $12 per sheet and up to domestic or exotic woods retailing at over $50 per sheet. Information from distributors indicates that there has been a perceptible decline in demand for the low price 4x8 sheets.

Therefore, though the supply overview appears favourable, there appear to be demand problems. Detailed research is needed of market factors before any reliable estimate can be made of the market potential for a new thin particleboard plant located in Alberta. **Subject to the findings of such research it is appropriate to rate the market outlook for this grade as moderate.**

OPTION #12

SPECIALTY PLYWOOD

There is considerable production in Europe of plywood laid up with a large number of thin veneers and no core gaps. Production of this type of product is very limited in North America and some smaller, specialty, cabinet shops are using plywood of this type imported from Finland.

Technical Feasibility

Assuming that high quality logs with few knots and limited decay are utilized, technically the product can be manufactured. A quantity of logs were sent to Japan in 1983 for testing by the Shimane-Ken Plywood Association. Though many of the logs sent were apparently unsuitable, the

Japanese mills found that veneer in thicknesses down to 0.6 mm could be peeled satisfactorily. So far the original trials, which were completed about a year ago, have not lead to any further action. However there appear to have been a number of reasons for this and the lack of follow up does not necessarily suggest that there is any technical constraint related to the best quality of logs. It should be noted however that the veneer yield was low, at only 35 per cent, even from the better logs.

Production technology is not available in Alberta and would have to be imported from Japan or Europe. **From the viewpoint of technical feasibility, this option is rated as 'moderate.'**

Economic Feasibility

There is little doubt that product would be expensive to produce. Only the highest quality logs would be suitable and the 'multi-ply' approach results in a large number of glue lines. Since the potential market is located in the larger population centres transportation costs are likely to be high. However, this would be a high value product thus freight costs are a relatively small proportion of delivered price. **A moderate rating has been assessed.**

Market Outlook

Though contacts with smaller cabinet shops indicate that there is a need for this type of product the size of the potential market is not known. There is only limited production of this type of product, mainly from the U.S. South, but there are a number of market niches where it is used. An example in Southern Alberta is a manufacturer of hockey sticks using plywood imported from the U.S. and, on occasion, from eastern Canada. **From a market viewpoint, this option is given a moderate rating.**

OPTION #13

CONSTRUCTION LUMBER

The production of construction lumber must be analyzed in the context of the type of product to be manufactured. There are essentially three broad categories.

- dimension lumber in the standard variety of sizes and lengths
- finger jointed dimension lumber as above
- studs
- finger jointed studs

The processing options for each of these varies but in order to avoid repetition they are discussed together.

Technical Feasibility

Due to the defect characteristics and variable moisture contents aspen tends to be more difficult to manufacture than species in the S-P-F group. New production techniques have been developed to overcome these problems but, as yet, relatively few companies are utilizing them. For example, a recent seminar on the S-D-R (Saw-Dry-Rip) approach in the Lake States attracted only three industry participants in spite of extensive publicity.

Other techniques have been tried, involving rough sawing oversize and extended periods of air drying. One of these experiments resulted in good quality lumber but at a handling cost 15 per cent above S-P-F and a lower yield factor. **This option is rated as moderate in terms of technical feasibility.**

Economic Feasibility

Bearing in mind that construction lumber manufactured from aspen must compete with S-P-F the actual manufacturing costs for aspen are comparatively high. Furthermore, unless the quality of logs being sawn is adequate the lumber recovery factor is also low. Consequently, even though the cost of aspen on the stump and the cost of hauling to the mill may be lower than for S-P-F, the cost of raw material per unit of lumber produced is poor. This disadvantage becomes less apparent, however, as the length of the pieces required becomes shorter. Thus the economics of production for finger jointed studs from aspen would be more attractive than for random length dimension lumber.

It should be noted however that the experience of manufacturers of aspen studs has not been favourable. The North American Stud Co. was established in Slave Lake in 1971 with a design capcity of 60 million board feet. After some success during peak markets for lumber the mill closed permanently in the mid 1970's.

Production economics are very sensitive to log quality and size. The data developed in a study by the U.S. Forest Service indicate the substantial differentials in grade yield depending on the quality of logs. This is discussed further in the section on specialty lumber. Other information on grade recovery is contained in reports by Bailey and Forintek. **The economic feasibility is rated as moderate to low for northern Alberta.**

Market Outlook

S-P-F construction lumber is regarded as superior to aspen lumber - particularly for any area where there is significant ambient moisture. Consequently aspen must be sold at a substantial discount except at times when demand exceeds supply. At present, despite reasonably strong volume demand from the U.S., the supply of construction lumber is well in excess of demand. This has resulted in very low prices, even for S-P-F lumber. There is little reason to believe that this problem will be solved by any substantial increases in demand. It seems inevitable that, sooner or later, supply will be curtailed as the least efficient mills find it impossible to continue operations. However, even with some reduction in supply, it is difficult to foresee any radical change in the supply/demand/price situation.

It must be concluded therefore that the market outlook for construction lumber produced from aspen is low. There is always likely to be some demand from very local users but the volumes are too small and too irregular to justify the establishment of any additional full scale facility.

OPTION #14

INDUSTRIAL HANDLING LUMBER

This lumber is utilized in a number of forms in connection with materials handling. These include:

- pallets
- pipe racks
- cable reels
- dunnage
- crate shook
- packaging
- rail car doors

The majority of any aspen lumber produced in Alberta and the U.S. Lake States is consumed in these uses.

Technical Feasibility

There are few technical constraints related to the production of this type of lumber. A standard one or two man 'bush' mill can readily produce saleable product. The technical feasibility is high.

Economic Feasibility

Though quality requirements are low for the product, the use of small or highly decadent logs has a very direct effect on the economics of production. This is made worse by the lack of any value for the sawmill residue.

Current mill returns in Alberta for lumber in this category are around $140 per thousand board feet. At this level of return it is only the small independent operator, with low labour costs and negligible capital investment costs, that can operate at a profit. The reason that aspen lumber is sold for these uses is primarily price. There is no particular advantage relative to species. The economic feasibility is moderate to low.

Market Outlook

Since the value of the product is low the geographical area in which it can be sold is limited. Otherwise transportation cost becomes too great a factor. Demand therefore depends on the level of industrial activity within Alberta. There is substantial flexibility in existing supply capacity since many of the mills operate only sporadically, based on supply from local farmers or on short term licences from the provincial government. **The market outlook for any major facility producing lumber in this category - even as fall down from the manufacture of other grades - is therefore not promising, and it is rated as low.**

OPTION #15

Reconstituted Lumber

There are new technologies becoming available for the production of lumber by reconstituting the fibre. The earliest of these was "extruded" lumber. This was essentially particleboard, sometimes with a veneer overlay, and produced in regular construction lumber sizes. It has not, so far, been a success and is not included in the following analysis.

A more recent development has been Laminated Veneer Lumber (LVL). The log is peeled into veneers and the veneers are glued together with parallel grain orientation. The only consumer of any significance of this product has been Trusjoist. This company purchases the veneers, grades them mechanically to identify strength characteristics and then laminates the veneers into various lumber sizes for use as high strength top and bottom cords for a patented floor joist. It is also believed that a Finnish company has been selling LVL to the U.S. South and this may lead to the establishment of a new facility to manufacture the product in North Carolina. In addition there is a small "in-house" facility at a furniture plant in the U.S. utilizing oak veneer.

A third and even newer development is "Parallam" patented by MacMillan Bloedel. Again this product commences with veneer which is then broken down into strands. These strands are glued together to form lumber in various dimensions. The major advantage of the product is the exclusion of any defect and the fact that it has high strength characteristics which can be precisely controlled.

Technical Feasibility

The quality of fibre from the aspen resource is likely to be satisfactory for all these products. The technology for LVL production is reasonably well established but not widely proven at a commercial level in North America. It would seem unlikely however that the technology for "Parallam" or even "Scrimber" (a somewhat similar process developed in Australia) will be readily available from the companies that have patented it. **Technical feasibility is moderate.**

Economic Feasibility

Since the products depend on the initial production of veneer many of the disadvantages identified earlier, relative to plywood, would apply. The vital need for only the best quality logs is, however, somewhat mitigated since the production process for LVL should allow for selective removal of the defective parts of the veneer sheets and strips. This would tend, though, to increase production costs compared with LVL manufactured from S-P-F or other softwood species. **The economic feasibility is low.**

Market Outlook

Current market prospects for LVL are not encouraging at the prices needed to cover production costs. **The market outlook is rated as low.**

OPTION #16

Specialty Lumber

There are a number of specialty lumber products of high value that are required in the markets and could be produced from aspen. These would include:

- panelling
- edge glued boards
- shelving
- furniture parts/components
- upholstered furniture framing
- bed frames
- mouldings
- chop stick blanks
- turnings
- novelty items

Many of these uses require only relatively short lengths. For example, in a study on the furniture and cabinet industries in the U.S. it was found that 70 to 80 per cent of all lumber requirements were less than 36" long. Some sectors such as panelling and mouldings require longer lengths but others such as turnings or chop sticks are even shorter than 36".

Technical Feasibility - High/Medium

The technology to extract the necessary grades and sizes from aspen is readily available. There are, however, new computer based technologies that are becoming available that will result in yield improvements and reduced labour costs. Any major facility designed to produce specialty products will need to acquire this technology in order to compete.

Aspen fibre is technically suitable for the production of many specialty products though it is at some disadvantage to most other hardwoods such as birch, maple or alder. It should be noted, however, that balsam poplar tends to be unsuitable for many of the specialty products due to excessive stain.

Economic Feasibility

The growth characteristics of the aspen tree are such that there is, potentially, a considerable volume of good quality clear fibre available. Unfortunately this potential is only realized when the tree is over 70 years old and if it has not be subject to any form of insect or fungal attack. Thus the economics of extracting the quality requred are largely controlled by the decay factor. An analysis of over 600 trees in Minnesota carried out in 1978 demonstrated the effect of log quality relative to grade yield. It was found that, whereas logs graded as #1 produced 60 per cent of No. 1 common and better lumber, a #3 grade log only produced 25 per cent. Since it is only the higher grades that are required in many of the uses it can be seen that a facility based on the extraction of specialty lumber products is dependent on good quality logs. In a study of several hundred pieces of rough green 2x4s produced from aspen it was found that large volumes of 3' to 4' clear lumber could be obtained.

A number of studies have been undertaken in North America addressing the economics of producing aspen lumber for industrial uses. Though producers are often "excited by the possibility of producing clear lumber" most have not continued after some trial runs because the recovery has been too low to provide economic returns. Others have not proceeded due to an inability to secure long term supply of quality aspen. It is worth noting that in Ontario there are some facilities that emphasize the production of the higher grades of aspen lumber - particularly for furniture. This is in sharp contrast to other regions where aspen lumber has been mainly for low grade uses. These companies are having increasing difficulty obtaining the grade of raw material needed to produce sufficient high grade lumber.

Though there is no doubt that there is a considerable volume of clear fibre available within the total resource, the economics of processing logs and extracting saleable lengths of clear lumber are extremely variable. The viability of any operation depends on the average return obtained for all the fibre processed - not just the best portion. **On the basis of logs 12" and up in diameter and with no more than 15 per cent decay it is judged that the rating for economic feasibility should be moderate.**

Market Outlook

There is an increasing demand, at the industrial user level, for a raw material that is specifically produced for the user. Many wish to concentrate on the manufacture and sale of their own product without the need, first, to remanufacture lumber. Thus there is an increase in demand for precut components that can be directly assembled with the minimum of additional manufacture.

In order to satisfy this trend primary manufacturers are becoming more innovative at developing the necessary sizes and grades directly from the log instead of subsequently from lumber. Often the lumber that is remanufactured to produce the specialty item is not best suited for that item. Though this approach is being slowly developed there is, still, a substantial gap between the supply of user oriented product and the demand that is apparent.

It is believed therefore that the market outlook for specialty products is potentially excellent given an aggressive and knowledgeable marketing effort.

It is also worth commenting on a specific market sector outside the industrial uses discussed above. The potential for solid wood panelling appears favourable. It was commented earlier (relative to thin particleboard) that there has been a decline in the demand for low price 4x8 sheets for wall panelling. Part of this decline can be attributed to an increase in the demand for solid wood panelling. Some sample volumes of aspen panelling in 1"x6" have been produced and these appear to have an excellent potential if sufficient volume of quality boards can be developed from the fibre. There is also a potential market for much thinner (5/16" x 4") decorative V-joint panelling. It should be noted, however, that even though there has been some production of this product available from Colorado for many years, the volumes have shown little sign of growth. The development of these retail oriented products depends on a strong distribution system and aggressive sales promotion.

In summary, the potential markets for specialty lumber products are promising. They are rated as high to moderate. They are, however, very diverse and need a substantial amount of marketing effort.

CHAPTER SUMMARY

- Based on published data, and the consultants' experience and judgement, various wood product development options utilizing hardwoods have been considered for northern Alberta.
- These options have been evaluated, on a stand alone basis, using three criteria. They are a) technical feasibility b) economic feasibility and c) market outlook. In most cases, the findings are preliminary but nevertheless are believed to be reasonably indicative of true development potential over the next decade. The results are summarized below.

Table 6-2

Preliminary Feasibility Assessment for Hardwood Wood Product Options in Northern Alberta

#	Short-listed Options	Technical	Economic	Market
8	Waferboard OSB	H	M/L	L
9	Construction Plywood	M	L	L
10	Medium Density Fibreboard	H	M/L	L
11	Particleboard	H	M/L	M/L
12	Specialty Plywood	M	M	M
13	Construction Lumber	M	M/L	L
14	Industrial Handling Lumber	H	M/L	L
15	Reconstituted Lumber	M	L	L
16	Specialty Lumber	H/M	M	H/M

- It is stressed that much additional work would have to be carried out to confirm the initial findings, and to identify other relevant factors.

- The short-listed wood products development options are ranked in the table below in terms of most probably likelihood of success in northern Alberta.

Northern Alberta: Ranking of Hardwood Wood Product Development Options

Most Promising
Specialty Lumber

Longer Term Potential
Waferboard/OSB
Specialty Plywood

Possible, But Not Given a High Ranking
Medium Density Fibreboard[1]
Particleboard
Industrial Handling Lumber
All others

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[1] i.e., in addition to AEC Ltd. plant under construction.

7.0

INTEGRATED DEVELOPMENT OPTIONS FOR WOOD PRODUCTS

Satellite Operation

The potential viability of the majority of the processing options in the wood products sector has been shown to be unfavourable. An exception, however, may be the production of a variety of specialty lumber products. This is heavily dependent on the availability of good quality logs. Discussions with the larger companies indicate that many have considered the possibility of specialty lumber production but the problem has always been the volume of down graded lumber that inevitably develops.

This problem has lead to the suggestion that an integrated operation is essential. The creation of a 'satellite' facility linked to a much larger operation, such as a pulp mill, appears feasible, at least conceptually.

In this conceptual operation there could be a number of key features that contribute to its economic viability.

- Harvesting and debarking are a part of the large pulp mill operation.
- Only a small proportion, say the best 20 per cent, of the logs are diverted to the primary headrig operation.
- The headrig only extracts the quality fibre from the log. As soon as defect becomes apparent no further work is done on the log and it is directed back to the pulp mill chipper.
- The size of the further breakdown and remanufacturing facilities will be related to the volume of quality fibre that is expected to develop.
- The residue developed from these facilities is also directed back to the pulp mill chipper.
- The satellite facility only pays the pulp mill for the fibre that is actually converted into saleable lumber since the pulp mill recovers the balance at no extra cost.
- The traditional problem of disposal of fall down is minimized since only good quality fibre enters the remanufacturing facilities.

It is clear that there are a number of attractive aspects to the concept. There is however one major potential problem. In overall terms it is probable that the best 20 per cent of the pulp mill harvest would on average, yield the desired quality. However at any one time the pulp mill may not be harvesting sites that contain the "average" quality. Thus there may be periods of several months when the sites being harvested fail to yield a sufficient volume of quality logs. In theory, logging plans could be developed that would ensure sufficient good quality but there is considerable difficulty in predicting aspen quality prior to felling.

Unfortunately it is not possible to assess the impact of this potential constraint without investigating a site specific situation. The examination and development of the pulp mill complex has to come first since the wood product concept is only ancillary to this. Once the harvesting area for the main complex is established and experience is obtained on typical qualities, it should be somewhat easier to define whether the resource quality will be adequate, on a consistent basis, for a satellite operation. The development of the satellite operation would therefore have to be considered some time after the initial pulp mill.

Small Business Options

It has already been pointed out that there does not appear to be any significant potential for new capacity to produce low value lumber for inustrial handling. Higher value specialty products have better potential but are only economic if very high quality logs are used. Such logs are available on some sites but only on a selective basis. Furthermore they are often difficult to identify until the tree has been felled. It is worth emphasizing, however, that a number of the small operations contacted indicted that, with their extensive experience in the business, they believed that they were reasonably accurate in their predictions from outside indicators such as nodes, broken branches and so on.

It is possible, therefore, that a number of small operators could exist if they were allowed to log on a very selective basis. From the resource management point-of-view this could, however, present some problems. Apart from provincial forestry policy considerations, there could be difficulties. Where the trees are within areas that have already been allocated, and this would apply to much of the sites that are more easily accessed, the company with the allocation is likely to resist losing the best trees. Even where the resource has yet to be allocated the existence of several small independents removing the best aspen could prove a negative factor to a potential investor.

It does not seem, however, that these difficulties are insuperable. The number of small operators can be limited and their volumes and areas of operation controlled so that any impact on large companies is minimized. Also it is worth noting that the large complexes such as pulp mills, or waferboard plants, are much more tolerant of raw material quality than a small specialty lumber facility. Thus while a pulp mill can, if necessary, use a great proportion of 'woods run' quality, a specialty lumber operation, producing a high value product, can only be economic with the high quality log.

Even if it is assumed that the resource allocation aspect can be resolved, problems still exist at the production and marketing level. By definition, the type of operation is small and therefore has limited production sophistication and even less marketing expertise. Yet success in the manufacture of specialty products depends on:

- consistent volumes and precise specifications
- extensive distribution and marketing since the products are designed for very specific markets.

It would be difficult for an individual small operator to satisfy these requirements.

A possible solution may lie in the development of a cooperative approach. Several small operators could undertake to supply agreed volumes of rough cut lumber of the required grade and size to a centralized further processing plant. This facility would have the necessary equipment to dry and dimension, profile and/or cut to length the lumber to the precise needs of the customer. The further processing plant would also have the responsibility of developing sales outlets and the necessary distribution network. Where the small operator is able to produce, directly, a saleable product then this could also be marketed through the same cooperative company. It is also possible that, if there is excessive falldown developed by the small operator which can't be disposed of for local construction or materials handling, then upgrading operations such as finger jointing or edge gluing could be included in the centralized facility.

Clearly the economic feasibility of such an approach needs detailed analysis. A first consideration, however, is whether sufficient suitable raw material can be made available to the small operators on a long term guaranteed basis.

New Technology

The potentially most significant new technology relative to hardwood utilization is the development of a new waterborne polymer by Dr. Ramesh Vasishth.

The polymer is applied by a simple dipping process to rough green lumber. It is stated that it then diffuses throughout the material and attaches to the cell walls. Once the lumber dries the polymer prevents the reaccess of moisture.

The apparent benefits are:

- The wood can be treated adequately for prevention of decay in ground contact.
- The lumber can be kiln dried with a very substantial reduction in warp, twist and splits.
- The lumber machines better with a less fibrous appearing surface. Sharp profiles can be obtained.
- The surface is harder.
- The strength is improved.

- Rotten and decayed wood is stabilized and provides a serviceable surface.
- Knots are fixed more firmly and won't fall out.
- Even bark can be stabilized so that it retains contact with the wood.

The cost of application varies with the percentage of the product in the water solution. At 4.0 per cent, which is said to be adequate to achieve most of the above results, the cost is around $50 per thousand board feet of lumber treated.

At this stage most of the claims have yet to be proven by any totally independent authority. A pallet made from aspen and treated with the polymer was tested by Forintek in Ottawa and it is said that the results indicated that it was equivalent or better to a pallet made from alder. Some kiln drying tests were also undertaken but these proved inconclusive either to a lack of control or the use of unsuitable equipment. There is also a test currently underway with 2,000 fence posts that have been treated. The results of this test are currently not available.

The Alberta government, which holds the rights to the patent, are in the process of commissioning a major test programme related to the polymer. This programme, however, is designed to investigate the activity of the polymer rather than to test the performance of lumber that has been treated. The results are due March 31st, 1985 at which time it should be possible to obtain a much better indication of the potential of the polymer.

Should the polymer prove to be effective in achieving the claimed results at the costs indicated, the opportunity for the development of new solid wood processing facilities would be dramatically improved.

CHAPTER SUMMARY

- The potential viability of the majority of hardwood based processing options in the wood products sector has been shown to be unfavourable. The exceptions to this, on a stand-alone basis, are discussed in Chapter 6.0.

- A possibility would be a satellite facility linked to a much larger operation, such as a pulp mill.

- A conceptual evaluation of this integrated option is discussed in this section.

- A number of problems exist, particularly with regard to the logistics and economics of log flow. It is concluded that much more work is required before this option can be assessed properly.

- Apart from this satellite type of operation, there appear to be some opportunities for small operators if they were allowed to log on a selective basis. Additional evaluation might invalidate this conclusion. The main problem relates to existing allocations of timber. Further evaluation of this option is beyond the scope of this study.

- A waterborne polymer, still in the experimental stages represents a potential for increased hardwood utilization. If the polymer can achieve the desired results of stabilizing and strengthening the wood the opportunity for development of a solid wood product would be greatly improved.

8.0

EVALUATION OF CONSTRAINTS AND FORMULATION OF STRATEGY

This section brings together the analyses of the previous sections. It examines constraints to development of the forest product options identified in the study. Implications for strategy are considered and recommendations for further action are outlined.

Despite Considerable Potential, A Number of Serious Constraints to Development Exist

One of the keys to successful economic expansion of the unutilized portions of the forest resources of northern Alberta is the development of an adequate transportation infrastructure. In many respects, however, this is a "chicken-and-egg" situation. On one hand, development of the full potential cannot be achieved without a) adequate physical infrastructure and b) the availability of rail/truck service offering a competitive rate structure for shipment of product. On the other hand, the economic provision of the physical infrastructure, beyond that which exists today, and the development of a competitive rate structure (e.g. rail) depends on the existence, or potential development, of a viable industrial base.

This study has indicated a reasonably favourable aspen resource situation in, for example, the Fort Vermilion area, yet the nearest rail point is at High Level. There are many similar examples. It is not possible, because of the general nature of this study, to conclude that the absence of an adequate physical infrastructure is the major factor precluding an industrial development. This would require site-specific study. Nevertheless, a basic principle can be identified. This is that for industrial development to proceed in these circumstances, realistically there must be public sector participation in the costs involved.

The detailed analysis of transportation rates, again, is beyond the scope of this study. In some areas there is a choice of transportation modes, but no choice in others. De-regulation of rail transportation in the U.S. is having a dramatic impact upon freight rates and service in North America and, in almost all cases, rates are now directly negotiated between carrier and shipper.

Transportation distances, road haulage weight allowances and transportation cost have been cited in some cases as negative factors affecting the viability of potential forest industry investments in northern Alberta. Any of these may be valid claims. It simply is not possible, in a study such as this, to identify any broad transportation-related constraints which may be precluding new forest product manufacturing investment in the area.

There are other serious and diverse constraints to development. First among these is the issue of business climate. A good business climate is conducive to new investment: a poor one obviously is not. There are two aspects of business climate. The first aspect is the existing image of an area such as northern Alberta (and more generally of Alberta and, in turn, Canada) for forest products investment. The second aspect is related to information. It involves the identification of specific investment potential and it's active promotion through business development.

Business climate is an intangible but very important factor in determining the attractiveness of an area for new capital investment. It is a particularly strong factor where investment is being considered by companies based outside Alberta, on either a direct or joint-venture basis. A recent study[1] addressed the issue of Alberta's business climate based on a small, but probably representative, sample[2] of interviews in the U.S. The following comments are extracted from this report.

"The U.S. paper brokers and merchants visited during the field work were asked their opinions on the relative attractiveness of various regions of Canada as (potential) suppliers of printing and writing papers. The following is a synopsis of the most typical comments regarding Alberta. The comments are presented with the objective of clarifying possible impediments to economic development and means of overcoming these constraints.

- As a forest products manufacturing province, Alberta is perceived to have considerable underutilized potential. Publicity surrounding proposed/possible plant expansions by companies (e.g. St. Regis, BCFP) and the Brazeau Timber Development Area proposal have created a high degree of awareness in North America and internationally.
- Nevertheless, Alberta is perceived to have some comparative disadvantages. Paramount among these perceptions is the image, among many paper brokers and merchants, of Alberta as an area whose potential is likely to be realized later rather than sooner.
- They cite the perceived procrastination regarding the Brazeau decision; the postponement (and now cancellation) of the Hurdy newsprint mill and the alternative (now cancelled) softwood kraft mill proposal for Whitecourt; the apparent lack of progress in using the aspen resource; and the perceived loss of investment interest by U.S. and Canadian companies, such as Simpson and more recently BCFP, as contributing factors.

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[1] Woodbridge, Reed and Associates Ltd. 'Printing and Writing Paper Manufacturing in Alberta: Development Opportunities'. Prepared for Alberta Economic Development.

[2] These comments are based on the sample of brokers/merchants interviewed and do not necessarily represent overall opinion.

- There were favourable comments about Alberta's labour-management record in the forest products industry in contrast to very critical comments about other provinces, a few of which are perceived to have endemic problems in this respect.

- A few persons interviewed mentioned, favourably, the work being done in aspen utilization/development by institutions such as the Alberta Research Council and Alberta Forest Service.

- Alberta is perceived to be favourably disposed politically to investment from other countries and there is a beneficial spill-over image from the oil and gas industry in terms of Alberta's pragmatic policies towards joint-venture resource development.

- There were some comments about Alberta's distance from major U.S. market areas and it appears to be assumed fairly widely (wrongly, in some cases, in our view) that exceptionally high transportation costs and limited developed infrastructure could preclude any major role in printing paper manufacturing."

Fewer Studies Are Needed: and More Promotion is Required

Alberta scores very well in producing information and studies related to aspen potential. The evidence for this is the extensive number of literature citations contained in the appendices to this study. Alberta scores less favourably, however, in the identification and active promotion of specific investment options.

It should be recognized that in the past few years, many competing supply areas to northern Alberta have taken some unprecedented steps to attract new investments into their areas and to encourage existing industry to expand in higher value-added products. These steps include a wide range of incentives ranging from information packages for specific sectors (e.g. quantifying favourable investment conditions) to comprehensive financial and taxation treatment. Examples include some U.S. states and many overseas countries.

In the pulp and paper industry specifically, there has been a major and positive shift in the attitude of local and state/provincial governments to this sector compared with a decade ago. In the buoyant demand conditions of the early 1970's, when very favourable growth rates were anticipated to continue for a wide range of products, it was comparatively easy to attract new investment. Today, the situation has been reversed. Companies seeking expansion are faced with tough competitive conditions. They are selective in their investments and they are attracted to those areas which offer the greatest potential for success and which minimize the business risks inherent in new ventures.

In the context of higher value papers, for example, it is essential for a producer to be able to guarantee continuity of supply to the purchasers of these products. Magazine publishers, a growing number of which are in the Los Angeles area, try to minimize the amount of capital tied up, for example, in LWC paper inventory and face major penalties (e.g. loss of circulation, loss of advertising revenues, etc.) if supply continuity, or quality, is disturbed for any reason.

There is only one essential factor which has to be considered with regard to the production of higher value papers. There are many others. The risk factors are greater in the move to higher valued products. Grade specifications become tighter, and product handling becomes more critical. The potential for profit is relatively greater, but the potential for failure is also greater.

Areas which offer the best investment climate usually are the first to attract new investment. Canada's recent history has not been good in this respect and, compared with earlier decades, only a limited amount of new investment has taken place in the forest products industry over the past ten years. It appears probable, that without such changes, much of the potential for higher value paper and board production in northern Alberta may not be realized.

For Some Product Opportunities, The Lack of External Economies is a Constraint

Any region which has an established industrial structure in a particular technology, normally offers certain advantages to complementary industries commencing operations in the area. These external economies include an established labour force in the technology in question; management skills and various other factors such as an established infrastructure (e.g. suitable rail stock for shipping comparatively high valued papers); an established distribution network and so on. In this regard, regions such as northern Alberta have external economies in bleached softwood kraft and newsprint. The U.S. Midwest has external economies in LWC papers and the U.S. Northeast (non-integrated) and U.S. South (integrated) in u/c woodfree papers. The existence of these factors enhances the relative attractiveness of one region over another for new related investment.

Northern Alberta's external economies in forest products are limited, at present, to currently produced items such as softwood lumber, waferboard and market pulp. For some of the new product opportunities identified in this study, the limited external economies which exist in northern Alberta are not necessarily an unsolvable problem providing that at least some of these factors (e.g. key trained operating personnel and management) can be brought into the region by an established producer of such grades from another region, or where such skills can be obtained through joint-venture, or affiliate, arrangements involving the producer and paper maker/paper user.

In another respect, however, northern Alberta does have reasonably good future prospects as far as development of its existing product base and related new products (e.g. market pulp) are concerned. The region already has a well established lumber, waferboard and bleached kraft pulp industry and most of the highly rated forest product development options identified in this study capitalize on these existing strengths.

An Aggressive Approach to Development Promotion is Necessary...

In view of the analysis, summarized above, one of the strategy recommendations being made to the NADC is direct future policies towards the active promotion of the aspen-based products short-listed in this study. These are the ones which optimize northern Alberta's comparative strengths (competitive wood costs, its fibre resource quality and Alberta's plentiful supplies of low cost energy, compared with areas such as the U.S.).

...But Only After Development Strategies Have Been Carefully Considered

It is essential that before active promotion is undertaken, the NADC carefully consider its forest industry development strategy options. An important part of this will be to coordinate this process with initiatives being undertaken by provincial government departments. Specifically, possible locations for an LWC plant (one of the options available to northern Alberta) have been discussed in southern Alberta. Clearly, uncoordinated active promotion of the same development option, in say the U.S., by two or more organizations from Alberta would have an adverse impact on Alberta's chances of success.

Once Decided, These Strategies Should be Pursued Consistently

Experience in areas seeking development in forest products has shown that success normally is greatest where a) viable development options have been correctly identified before development initiatives have been undertaken and b) where the development authority has not tried to be "all things to all men." It is the responsibility of the NADC to satisfy itself that a) has been adequately researched. Subsequently, with respect to b), it will be **imperative to be consistent** in promoting the product options in which northern Alberta will be claiming it can offer very competitive and attractive investment conditions.

Even So, Development Will Be Gradual

Even under optimum business climate conditions in northern Alberta, it should be recognized that future expansion of the forest products industry in northern Alberta would be gradual. A few of the product options appear to have immediate investment potential, as discussed earlier, and the employment and income implications could be significant. Most others are medium to longer term. Clearly, it is possible, through special measures and incentive programs, to bring forward some of these medium and longer term options, as discussed earlier.

Three broad criteria have been used to evaluate potential development options (i.e. technical feasibility; economic feasibility and market outlook). In product options identified, northern Alberta varies in its ability to compete with other areas on each criterion. Moreover, many product options have been researched only at a general level and more specific targetting of future study work is required.

For general planning purposes, however, the very approximate timing of aspen-related forest products development in northern Alberta, under current assumptions, can be summarized as follows:

APPROX. TIMING OF FOREST PRODUCT DEVELOPMENT OPTIONS FOR NORTHERN ALBERTA

Period	Investment Options which Could Prove Viable
1985-1990	Aspen/Spruce Bleached CTMP
"	Light Weight Coated (LWC) Paper
"	Specialty Lumber Operations
1990-2000	Aspen Bleached Kraft Market Pulp
"	Uncoated Groundwood Papers
"	Waferboard/OSB
Beyond the year 2000	All Other Short-listed Investment Options

Some Immediate Initiatives Should Be Considered

In order to facilitate the early development of the highly ranked forest product options in northern Alberta, three specific initiatives should be considered. These are:

1. Aspen Harvesting Policy

The government of Alberta has developed a flexible and negotiable approach to forestry development. Whilst the maintenance of this flexibility is desirable, some clarification of harvesting policy and resource availability is necessary in order that viable development options can be correctly identified.

Hardwood AAC's should be recalculated at the earliest opportunity, taking into account age class distribution, decay-age trends, and softwood harvest schedules. This should facilitate realistic identification of areas with potential for viable economic development.

In areas defined as having good potential, more detailed clarification of policy is necessary as a prerequisite to the promotion of targeted product-market opportunities. The availability of these forest lands for both long term and short term hardwood utilization should be clarified in relation to alternative uses such as softwood production and agriculture. In recognition of the fact that only a proportion of existing stocks are likely to be successfully utilized, it will be necessary to realistically define (in terms of accessibility and quality):

1. what components of the resource operators will be obliged to utilize,
2. what components will be recognized as unusable,
3. what obligations the public and private sectors have to rehabilitate unusable stands, and
4. how local discontinuities in supply (resulting from age class imbalances) may be accommodated.

2. Promotional Package

It is recommended that, when its development strategies have been determined, the NADC (in coordination with the provincial and the federal government) should consider the preparation of a promotional package specifically for forest industry development (involving available softwood and hardwood resources) targetted to specific product-market opportunities.

Various examples of successful promotional packages prepared for areas outside Alberta have been discussed with the NADC and the Steering Committee. They are principally designed to inform potential investors. The issue of the possible need for industrial incentives has been raised by the Committee. This issue is outside the scope of this report. Such incentives may be found to be necessary, but it is suggested that a) the need and b) the extent of any incentives should be determined independently of this report.

3. Active Marketing to Potential Investors

A program of active marketing should be developed, in consultation with, or carried out by, the provincial government. This could arise out of the recently signed Canada-Alberta Forest Resource Development Agreement and should continue over a 4 to 5 year period.

APPENDIX A

FORESTRY APPENDICES

1. Bibliography
2. Models Used for Assigning Decay Estimates
3. Typical Yields per Hectare of Well Stocked Stands
4. Delivered Cost Model
5. Management Units Ranked by Delivered Cost
   (also includes formal AAC's and average haul distances)
6. Regional Areas and Volumes
   (also includes volumes per ha by age class; areas given are for the whole of northern Alberta)
7. Management Unit Statistics for Maps 3 and 4.
8. Examples of Simulated Yields from Pure Hardwood Stands

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Models used for assigning decay estimates to inventory statistics and projections.

Stand Age (yrs)	% decay trembling aspen	% decay balsam poplar	% decay white birch
20	0.3	-	-
30	0.8	-	-
40	1.8	1.3	0.5
50	3.4	3.3	1.3
60	5.5	5.3	2.1
70	8.4	7.3	2.9
80	12.0	9.3	3.7
90	16.6	11.3	4.5
100	22.1	13.3	5.3
110	28.6	15.3	6.1
120	36.2	17.3	6.9
130	45.0	19.3	7.7
140	55.1	21.3	8.5
150	66.4	23.3	9.3
160	79.1	25.3	10.1
170	93.3	27.3	10.9

Aspen $\% \text{ decay} = 0.00008127 \times \text{Age}^{2.71695}$

Balsam poplar $\% \text{ decay} = (0.2 \times \text{Age}) - 6.680$

Birch $\% \text{ decay} = 0.4((0.2 \times \text{Age}) - 6.680)$

Typical yields per hectare of well-stocked natural aspen stands, site index 16.0 metres (at 50 years breast-height age), at various utilization standards.

Age (yrs)	Stand height* (m)	Net volume in m^3 per ha**				
		0/0 (total stem)	13/7 (small roundwood)	15/10 (large roundwood)	20/13 (small sawlog)	25/15 (large sawlog)
10	4.18	14.11	0	0	0	0
20	8.96	46.93	0	0	0	0
30	12.65	82.37	0	0	0	0
40	15.49	116.53	41.81	7.63	0	0
50	17.70	146.76	96.02	67.61	35.98	0
60	19.45	171.65	136.27	112.74	78.73	39.46
70	20.86	190.51	164.96	145.54	112.49	74.63
80	22.00	203.06	183.87	167.89	137.51	102.50
90	22.94	209.22	194.21	181.13	154.24	122.83
100	23.73	208.98	196.79	186.19	163.08	135.60
110	24.39	202.30	192.13	183.65	164.35	140.92
120	24.96	189.16	180.56	173.93	158.31	138.86
130	25.44	169.46	162.26	157.23	145.07	129.52
140	25.87	143.14	137.29	133.66	124.72	112.92

*Average height of 100 largest-diameter trees per hectare

**Utilization standard indicated by 2 numbers:

1st refers to minimum diameter measured over-bark at 30cm stump.

2nd refers to minimum top diameter inside-bark

i.e. 13/7 indicates volume measured to a top diameter of 7cm in trees with a stump diameter greater than 13cm.

Note: ----- indicates culmination of mean annual increment. The age at which this occurs corresponds to the rotation which maximizes long-term productivity of the site, providing the stand is not at risk.

4 Delivered cost model

The following model was assembled to predict cost in \$ per scaled m^3 as a function of haul distance and road requirement (in km).

Overhead	- reforestation, stumpage, holding & protection, inventory,	0.60
	- scaling (other yard costs not included)	0.35
	- general overhead	1.50
	OV =	2.45

Logging cost (on truck) LO =10.50

Roads (HD = km haul distance NR = km non-roaded distance)

Road maintenance etc. RM = 0.5 + 0.03*HD

Access development RD =-0.3 + 0.03*NR

IF (RD LT 0) RD = 0

Camp and commuting costs

CC = 0.01*HD

IF (HD GT 90) CC = 0.90

Hauling costs

HC = 2.5 + 0.052*HD

Total delivered cost \$ per m^3

DC = OV + LO + RM + RD + CC + HC

5. MANAGEMENT UNITS RANKED BY DELIVERED COST

Unit	AAC	Acc. AAC	Cost	Distance
W 7 B	8581	8581	16.87	10.00
G 10	.	8581	17.79	20.00
A 5	123447	132028	18.71	30.00
E 6 B	41517	173545	18.71	30.00
W 5	176688	350233	18.71	30.00
E 8	2039	352272	19.63	40.00
E 8 B	29396	381669	19.63	40.00
G 1	289799	671467	19.63	40.00
G 4	233215	904682	19.63	40.00
S 2	112345	1017028	19.63	40.00
S 5	376344	1393372	19.63	40.00
W 4	237293	1630666	19.63	40.00
A 2	115149	1745815	20.23	40.00
E 8 C	3540	1749355	20.55	50.00
G 9	.	1749355	20.55	50.00
P 2	274562	2023917	20.55	50.00
P 3	126902	2150819	20.55	50.00
P 6	239955	2390774	20.55	50.00
S 6	225031	2615805	20.55	50.00
W 2	166918	2782723	20.55	50.00
W 7	23024	2805747	20.55	50.00
F 8	81845	2887592	20.85	50.00
F 15	200364	3087956	20.85	50.00
L 1	196852	3284808	21.77	60.00
S 1	294556	3579365	21.77	60.00
A 1	43641	3623006	22.39	70.00
E 10	14670	3637676	22.39	70.00
F 12	145338	3783014	22.39	70.00
G 2	64343	3847357	22.39	70.00
L 2	216308	4063665	22.39	70.00
S 7	89661	4153326	22.39	70.00
S 3	198467	4351793	22.99	70.00
A 7	132141	4483934	23.31	80.00
E 7 B	18295	4502229	23.31	80.00
G 2 C	58594	4560823	23.31	80.00
G 3	201129	4761951	23.31	80.00
G 8 C	.	4761951	23.31	80.00
P 11	.	4761951	23.31	80.00
P 4	112091	4874042	23.61	80.00
W 1	86772	4960814	23.61	80.00
A 3	197220	5158035	23.91	80.00
G 5	249612	5407647	24.23	90.00
G 7	166040	5573688	24.23	90.00
P 5	90766	5664453	24.51	80.00
A 4	24299	5688752	24.81	80.00
L 6	150068	5838819	24.83	90.00
L 8	.	5838819	25.05	100.00
S 9	146018	5984837	25.05	100.00
W 3	194020	6178858	25.05	100.00
G 6	16426	6195283	25.35	100.00

MANAGEMENT UNITS RANKED BY DELIVERED COST

Unit	AAC	Acc. AAC	Cost	Distance
P 1	293622	6488905	25.35	100.00
F 7	34919	6523824	26.17	110.00
L 9	.	6523824	26.25	100.00
S 8	247970	6771793	26.47	110.00
F 18	59189	6830982	26.99	120.00
L 3	199571	7030553	27.51	130.00
P 7	73802	7104355	27.51	130.00
F 9	96005	7200360	27.81	130.00
A 8	59953	7260313	27.89	120.00
A 6	23194	7283508	28.11	130.00
G 5 C	256239	7539747	28.33	140.00
S 4	260997	7800744	28.33	140.00
F 5	81901	7882645	28.63	140.00
F 17	79862	7962508	29.15	150.00
P 10	89973	8052480	29.15	150.00
A 10	31690	8084171	29.53	140.00
L 4	89350	8173520	29.75	150.00
F 14	203564	8377084	29.97	160.00
S 10	231120	8608204	29.97	160.00
F 1	149954	8758158	30.05	150.00
F 19	74425	8832583	30.27	160.00
F 6	187280	9019863	30.57	160.00
A 11	5296	9025159	30.65	150.00
F 2	232026	9257185	30.79	170.00
F 13	110335	9367520	31.61	180.00
F 16	95665	9463185	32.21	180.00
F 10	19484	9482669	32.89	170.00
S 12	149360	9632028	33.03	190.00
F 4	65731	9697759	33.11	180.00
P 8	16765	9714525	33.11	180.00
L 5	77738	9792263	34.23	190.00
A 9	56215	9848478	34.61	180.00
F 20	6315	9854794	35.27	210.00
P 9	23392	9878186	35.79	220.00
S 15	138768	10016954	36.01	230.00
A 12	20390	10037344	36.25	200.00
S 11	80485	10117830	36.53	240.00
F 3	54884	10172714	37.21	230.00
S 14	96854	10269568	38.17	260.00
S 13	70205	10339774	41.83	290.00
A 13	51288	10391061	49.69	320.00

6 REGIONAL AREAS & VOLUMES; O, M, & INCOMPLETE UNITS EXCLUDED
MIXEDWOOD TYPES

Age	Area	Understory	Gross vol.	Net vol.	Vol/ha
270	5	.	214	39	7.5
240	7	.	32	9	1.3
230	84	.	8117	1396	16.6
220	194	.	4868	1512	7.8
200	289	.	13641	1432	5.0
190	133	.	3536	1637	12.3
185	610	.	49644	2984	4.9
180	2431	.	133521	15410	6.3
170	3798	.	203422	42260	11.1
165	4123	.	349325	76856	18.6
160	16287	.	1234845	388984	23.9
155	123	.	7181	2659	21.6
150	22320	.	1805430	739578	33.1
145	24486	.	1857644	848718	34.7
140	66707	.	4715232	2361440	35.4
135	1294	.	87638	47919	37.0
130	105108	.	7808522	4570329	43.5
125	74930	.	5765779	3634255	48.5
120	306494	.	23853369	15927846	52.0
115	928	.	74598	51225	55.2
110	159791	.	12347484	9081772	56.8
105	42173	.	3533709	2705621	64.2
100	288956	.	23431497	18666684	64.6
95	1625	.	147724	121380	74.7
90	275606	.	21134359	17893620	64.9
85	41211	.	2660508	2306690	56.0
80	161357	.	10264335	9107924	56.4
75	1917	.	104362	94551	49.3
70	171853	.	8201320	7550834	43.9
65	48462	.	2381379	2226736	45.9
60	168833	.	7050748	6684769	39.6
55	924	.	31205	29990	32.5
50	206388	.	6850081	6638683	32.2
45	61714	.	2152587	2104529	34.1
40	396971	.	17007363	16740708	42.2
35	77	.	198	196	2.5
30	68422	.	312710	310825	4.5
25	7089	.	20884	20814	2.9
20	59900	.	19469	19431	.3
15	85	.	0	0	.0
10	6412	.	3252	3251	.5
5	99	.	0	0	.0
0	1460	.	0	0	.0

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REGIONAL AREAS & VOLUMES; O, M, & INCOMPLETE UNITS EXCLUDED
PURE HARDWOOD TYPES
Age          Area    Understory    Gross vol.      Net vol.  Vol/ha

220            10             .          1242           121    12.3
190             4             .           195            53    13.9
185            25             .          4659           369    14.7
180           470            87         58581          9890    21.0
170           505            80         59883         11104    22.0
165           463            88         51782         17606    38.0
160           935            80        128487         39722    42.5
155            20             .           895           387    19.9
150          5518          1092        790039        328798    59.6
145         20756          7711       2277515       1136510    54.8
140         24263          4521       2879007       1495293    61.6
135          1221            88        121277         66971    54.9
130         37612          5001       4897089       2919560    77.6
125         38844         16306       4723334       3071564    79.1
120        159595         23693      21239257      14360563    90.0
115           626           323         93894         66479   106.1
110        100782         12299      14154472      10443694   103.6
105         27043         10874       3883822       2996332   110.8
100        278126         41325      38651743      30866667   111.0
 95          4609           540        818899        670075   145.4
 90        295759         65214      42768813      36200020   122.4
 85         61478         22753       8883671       7686376   125.0
 80        334112         92361      44061387      39037426   116.8
 75          5125           175        452113        408385    79.7
 70        508109        132203      57457238      52825522   104.0
 65         86894         21199       8614385       8040785    92.5
 60        741753        149328      66588730      63033766    85.0
 55          2241           215        287451        275009   122.7
 50        672090         63144      68020210      65790771    97.9
 45        111851          4951      11713827      11428880   102.2
 40       1251832         56419     125060884     122912043    98.2
 35            91             .          1289          1275    14.0
 30        121186           121       3415323       3392330    28.0
 25         19048             .        475233        473201    24.8
 20        123776            46        456615        455687     3.7
 15            32             .             0             0      .0
 10         13523             .          1180          1180      .1
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7 MANAGEMENT UNIT STATISTICS FOR MAPS 3 AND 4

Unit	Vol aspen	Vol poplar	Vol birch	Vol total	Area 0-45	Area 50-75	Area 0-75	Area 80+
A 1	961741	134218	122864	1218823	815	4222	5037	2196
A 2	5746230	945570	405163	7096963	16700	31034	47735	8638
A 3	5797087	945836	450937	7193860	37462	29069	66531	8958
A 4	1047897	143818	113074	1304789	8712	5821	14533	626
A 5	4250071	719420	392476	5361967	24760	17313	42073	5591
A 6	796495	123044	48570	968108	234	2944	3178	3909
A 7	9417293	1657867	599791	11674951	46502	25130	71632	15712
A 8	4422914	632637	502620	5558171	33274	5266	38540	1181
A 9	2060077	181829	44443	2286349	14599	4938	19538	1523
A 10	3344633	521298	337175	4203105	11762	33753	45516	2932
A 11	780493	94784	109015	984292	1032	8262	9294	593
A 12	566485	164794	139019	870298	2436	3068	5504	5294
E 6 B	854759	171828	53863	1080449	.	741	741	2963
E 7 B	117968	22023	7890	147882	55	79	134	194
E 8	13699	5017	1327	20042		.	.	211
E 8 B	597828	176038	21573	795439	358	684	1042	4639
E 8 C	193954	50187	9271	253412	324	898	1222	869
E 10	941140	328038	28880	1298059	2878	9189	12068	4416
F 1	14878255	3707887	873437	19459579	16790	145076	161866	5728
F 2	5372788	955362	105939	6434088	18008	19359	37367	15887
F 4	5707304	449562	297341	6454208	21864	47988	69852	10383
F 5	6754469	1006609	841012	8602091	32969	82176	115146	19828
F 6	4733957	739526	547433	6020915	17290	32927	50217	10246
F 7	3286118	547813	460679	4294610	40246	19983	60229	4147
F 8	3231743	529212	434988	4195943	2966	24438	27404	14103
F 9	2371488	395393	284583	3051464	9340	18986	28326	9180
F 10	69578	15734	12535	97847	438	959	1398	194
F 12	6389715	413751	444733	7248200	18209	23862	42071	4338
F 14	6531025	431024	411220	7373269	6004	19207	25211	13397
F 15	7597755	427048	369528	8394331	7885	24940	32825	21722
F 17	1334921	100620	94732	1530273	6753	9661	16414	870
F 18	1643803	151393	123456	1918652	11205	6725	17930	3600
F 19	162739	25830	18798	207367	582	1270	1851	534
F 01	14302157	1617320	1021918	16941394	91200	123874	215074	29643
G 1 P	14622732	4286507	797567	19706807	30420	50439	80859	21416
G 2	9118439	2456390	382832	11957661	16024	19145	35169	225
G 2 C	6972604	2022548	317017	9312168	6396	6238	12634	2710
G 3 P	8108605	2331062	349929	10789596	10008	31028	41037	33022
G 4	1175	335	28	1538	.	3	3	.
G 4 P	10469669	2442532	361843	13274044	8964	40010	48974	28457
G 5 C	8739000	1810528	386218	10935747	3696	28279	31975	29137
G 5 P	11452432	3521711	441801	15415944	4413	44088	48506	63016
G 6 P	391130	143076	25274	559480	2288	1703	3991	962
G 7 P	2829683	810780	156667	3797130	2258	2874	5132	14057
G 8 C	2481698	372897	78761	2933356	19945	3258	23203	390
G 9	1408674	370916	116135	1895726	3257	1813	5071	711
G 10	2019165	612559	82645	2714368	6211	2712	8922	410
G 01	7327684	1790148	290523	9408355	13559	27227	40786	17041
G 02	6171293	1389430	174536	7735259	5111	26296	31407	7208
G 03	4837389	1244294	261788	6343470	30386	20902	51288	1134
G 04	6870008	1715869	238848	8824725	21772	13933	35705	9877
L 1	8636448	1749936	381653	10768037	6757	48362	55120	28828
L 2	6200938	1391146	304082	7896166	21718	24111	45829	26899

MANAGEMENT UNIT STATISTICS FOR MAPS 3 AND 4

Unit	Vol aspen	Vol poplar	Vol birch	Vol total	Area 0-45	Area 50-75	Area 0-75	Area 80+
L 3	6822007	1324529	413316	8559852	6120	7347	13468	19684
L 4	4404342	781598	251027	5436967	3501	21067	24568	7645
L 5	2931074	488818	190319	3610211	1273	8912	10185	6638
L 6	8382281	1540114	508501	10430896	19293	49138	68431	15967
L 8	2563292	497710	162380	3223382	6414	12817	19231	5055
L 01	10214405	1899999	544080	12658484	37465	53605	91070	22912
P 1	6226318	1660986	372441	8259744	11514	4215	15728	12813
P 2	11474168	2594921	475974	14545063	22166	35438	57605	32715
P 3	9201954	2565908	645438	12413300	33236	25875	59111	11163
P 4	16048520	3577610	766211	20392341	67302	68804	136106	15714
P 5	13423157	3287662	847462	17558281	14866	62481	77346	19048
P 6	12252865	2144363	430607	14827836	13777	7980	21758	23468
P 7	7437153	1563482	504351	9504986	27342	6919	34261	17184
P 8	3918172	656529	658653	5233354	27114	2561	29675	3612
P 9	13229245	2140119	772115	16141479	75217	2528	77746	2992
P 10	15538749	2888429	1169867	19597045	45830	18776	64606	12087
P 11 C	861114	284552	44386	1190052	2637	86	2723	1803
P 01	3857595	872619	248744	4978958	25265	11422	36687	5895
P 02	8175250	1934613	352128	10461990	33501	16228	49730	20370
P 03	22361913	4778554	887896	28028363	44155	89596	133750	51775
S 1	16797675	77924	163090	17038689	31090	74088	105178	27822
S 2	5147567	1834742	423971	7406280	13872	13323	32195	23793
S 3	7351415	660167	27391	8038973	28803	3766	32569	20911
S 3 M	6793830	1437725	325050	8556605	54466	4870	59336	18939
S 4	10640656	1864487	168353	12673496	17547	29379	46926	46595
S 4 M	1110172	444858	110355	1665385	6150	3297	9447	6610
S 5	9580224	1783735	143597	11507556	17101	15485	32586	41386
S 6	3493306	1323378	222525	5039209	1023	2057	3080	25431
S 7	6124068	1029151	367835	7521054	21515	43664	65180	11942
S 8	7304024	1414584	116781	8835389	20409	7189	27539	16189
S 9	10503721	395058	56280	10955059	54189	12447	66637	15266
S 10	14536118	333433	41350	14910902	102551	19369	121920	25828
S 11	9764928	71641	20720	9857288	44255	26568	70823	9341
S 12	5709642	57035	29702	5796380	66903	6389	73292	10706
S 14	8581280	543648	99820	9224747	47366	35488	82854	9671
S 15	11376027	486679	79354	11942060	91494	16454	107948	15555
S 01	2191068	285523	91216	2567807	10223	8166	18389	4686
S 02	11003389	630588	139760	11773737	64355	15253	79608	21644
W 1	966457	202226	104831	1273514	2039	1657	3696	2779
W 1 B	1944112	426411	364405	2734928	3760	3542	7303	6773
W 2	4022264	997898	393914	5414076	34013	7717	41730	13326
W 3	5631560	1486005	335698	7453263	22528	16835	39363	15273
W 3 S	3140596	842496	206367	4189459	2058	2330	4388	14097
W 4	1803872	576232	187426	2567530	5388	3334	8722	9025
W 4 S	6380900	2073495	672882	9127277	13131	14808	27939	24151
W 5	6066803	1878911	356114	8301829	8779	6476	15256	39370
W 7	452735	75790	47826	576351	132	441	573	1345
W 7 B	355205	63367	39261	457833	206	50	256	932
W 01	1515013	470231	96361	2081605	3147	2282	5428	10389
W 02	1637448	599915	164715	2402077	11019	5999	17018	4597
W 03	190684	83163	26164	300010	328	3325	3654	270

```
8  EXAMPLE OF SIMULATED REGIONAL YIELDS FROM PURE HARDWOOD STANDS
   TOTAL AREA CONSIDERED IS 3744.8 (HA X 1000)
   70 YEAR SUSTENTION OF STANDS CURRENTLY LESS THAN 100 YEARS OLD

   AGE      ACTUAL      PERCENT     YRS. CUT    MEAN AGE    MEAN VOL    TOTAL VOL    TIME TO    CUMULATIVE    AREA CUT
            FOREST     OF TOTAL    ON  70 YR.   WHEN CUT    WHEN CUT    WHEN CUT     TO CUT        TIME       PER YEAR
             AREA        AREA      ROTATION


   999        4.1         0.1         0.1        999 0       145.8        597.9       0.10         0.10          4.10
    90      230.5         6.2         4.3         92.4       124.3      28646.3       4.63         4.73         49.76
    85       38.7         1.0         0.7         90.1       128.6       4977.8       0.80         5.53         38.70
    80      241.8         6.5         4.5         87.9       125.2      30269.5       4.89        10.43         49.40
    75        5.0         0.1         0.1         85.5        88.1        440.3       0.07        10.50          5.00
    70      375.9        10.0         7.0         84.2       123.8      46548.0       7.53        18.03         49.94
    65       65.7         1.8         1.2         83.6       123.2       8093.6       1.31        19.33         50.20
    60      592.4        15.8        11.1         85.6       132.2      78328.7      12.67        32.00         46.77
    55        2.0         0.1         0.0         87.0       128.1        256.1       0.04        32.04          2.00
    50      608.9        16.3        11.4         88.4       129.1      78606.6      12.71        44.75         47.91
    45      106.9         2.9         2.0         90.8       130.8      13984.6       2.26        47.01         47.28
    40     1195.5        31.9        22.3        100.1       135.5     161950.1      26.19        73.20         45.65
    30      121.1         3.2         2.3        104.5       137.7      16675.8       2.70        75.90         44.91
    25       19.0         0.5         0.4        101.1       136.0       2583.4       0.42        76.31         19.00
    20      123.8         3.3         2.3         97.6       134.2      16617.7       2.69        79.00         46.07
    10       13.5         0.4         0.3         89.1       129.7       1750.6       0.28        79.28         13.50

      CONSTANT CUT OF    6184.5    LIQUIDATES EXISTING STANDS IN      79.3  YEARS...DESIRED ROTATION IS    70    YEARS
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   AGE      ACTUAL      PERCENT     YRS. CUT    MEAN AGE    MEAN VOL    TOTAL VOL    TIME TO    CUMULATIVE    AREA CUT
            FOREST     OF TOTAL    ON  70 YR.   WHEN CUT    WHEN CUT    WHEN CUT     TO CUT        TIME       PER YEAR
             AREA        AREA      ROTATION


   999        4.1         0.1         0.1        999.0       145.8        597.9       0.09         0.09          4.10
    90      230.5         6.2         4.3         92.1       124.2      28620.2       4.17         4.26         55.29
    85       38.7         1.0         0.7         89.6       128.3       4963.[illegible]       0.72         4.98         38.70
    80      241.8         6.5         4.5         87.1       124.6      30119.9       4.39         9.37         55.11
    75        5.0         0.1         0.1         84.4        87.4        436.8       0.06         9.43          5.00
    70      375.9        10.0         7.0         82.7       122.2      45938.8       6.69        16.12         56.18
    65       65.7         1.8         1.2         81.7       121.0       7951.8       1.16        17.28         56.72
    60      592.4        15.8        11.1         82.8       129.2      76529.3      11.15        28.43         53.14
    55        2.0         0.1         0.0         83.5       124.7        249.5       0.04        28.46          2.00
    50      608.9        16.3        11.4         84.0       125.3      76302.7      11.11        39.58         54.79
    45      106.9         2.9         2.0         85.5       126.9      13560.9       1.98        41.55         54.12
    40     1195.5        31.9        22.3         93.0       131.9     157694.3      22.97        64.52         52.05
    30      121.1         3.2         2.3         95.7       133.2      16136.1       2.35        66.87         51.52
    25       19.0         0.5         0.4         92.0       131.4       2496.8       0.36        67.24         19.00
    20      123.8         3.3         2.3         88.4       129.1      15982.2       2.33        69.56         53.18
    10       13.5         0.4         0.3         79.6       120.4       1625.2       0.24        69.80         13.50

      CONSTANT CUT OF    6865.2    CAN BE MAINTAINED FOR      69.8  YEARS
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EXAMPLE OF SIMULATED REGIONAL YIELDS FROM PURE HARDWOOD STANDS
TOTAL AREA CONSIDERED IS 3229.7 (HA X 1000)
60 YEAR SUSTENTION OF STANDS CURRENTLY LESS THAN 80 YEARS OLD

AGE       ACTUAL     PERCENT    YRS. CUT    MEAN AGE    MEAN VOL    TOTAL VOL    TIME TO   CUMULATIVE   AREA CUT
          FOREST    OF TOTAL   ON  60 YR.   WHEN CUT    WHEN CUT    WHEN CUT     TO CUT       TIME      PER YEAR
           AREA       AREA     ROTATION


999         5.0        0.2         0.1       999.0        78.9        394.7       0.06        0.06         5.00
 70       375.9       11.6         7.0        73.3       109.2      41048.1       6.64        6.70        56.63
 65        65.7        2.0         1.2        72.2       107.2       7046.0       1.14        7.84        57.67
 60       592.4       18.3        11.0        73.3       115.3      68308.3      11.05       18.89        53.63
 55         2.0        0.1         0.0        73.9       111.8        223.6       0.04       18.92         2.00
 50       608.9       18.9        11.3        74.4       112.7      68604.3      11.09       30.01        54.89
 45       106.9        3.3         2.0        76.0       115.4      12340.4       2.00       32.01        53.57
 40      1195.5       37.0        22.2        84.6       130.9     156473.0      25.30       57.31        47.25
 30       121.1        3.7         2.2        88.6       138.0      16712.4       2.70       60.01        44.81
 25        19.0        0.6         0.4        85.2       131.9       2505.3       0.41       60.42        19.00
 20       123.8        3.8         2.3        81.6       125.5      15541.1       2.51       62.93        49.27
 10        13.5        0.4         0.3        73.0       110.1       1487.0       0.24       63.17        13.50

     CONSTANT CUT OF    6184.5   LIQUIDATES EXISTING STANDS IN      63.2  YEARS...DESIRED ROTATION IS    60   YEARS

AGE       ACTUAL     PERCENT    YRS. CUT    MEAN AGE    MEAN VOL    TOTAL VOL    TIME TO   CUMULATIVE   AREA CUT
          FOREST    OF TOTAL   ON  60 YR.   WHEN CUT    WHEN CUT    WHEN CUT     TO CUT       TIME      PER YEAR
           AREA       AREA     ROTATION


999         5.0        0.2         0.1       999.0        78.9        394.7       0.06        0.06         5.00
 70       375.9       11.6         7.0        73.2       109.0      40979.4       6.43        6.49        58.45
 65        65.7        2.0         1.2        72.0       106.8       7019.8       1.10        7 59        59.64
 60       592.4       18.3        11.0        72.9       114.5      67817.6      10.64       18.24        55.66
 55         2.0        0.1         0.0        73.3       110.6        221.3       0.03       18.27         2.00
 50       608.9       18.9        11.3        73.5       111.1      67639.8      10.61       28.89        57.36
 45       106.9        3.3         2.0        74.8       113 3      12116.4       1.90       30.79        56.22
 40      1195.5       37.0        22.2        82.7       127.4     152340.6      23.91       54.69        50.01
 30       121.1        3.7         2.2        85.9       133.2      16128.6       2.53       57.22        47.85
 25        19.0        0.6         0.4        82.4       126.9       2410.4       0.38       57.60        19.00
 20       123.8        3.8         2.3        78.7       120.4      14900.2       2.34       59.94        52.95
 10        13.5        0.4         0.3        70.0       104.8       1414.8       0.22       60.16        13.50

     CONSTANT CUT OF    6372.4   CAN BE MAINTAINED FOR      60.2  YEARS
```

Appendix B

GLOSSARY OF TERMS AND ABBREVIATIONS

Terms

advanced decay	The stage of decay when the wood is soft and visibly decomposed.
annual allowable cut (AAC)	The total volume or area of timber that may be harvested in one year.
brightness stability (paper)	The ability of paper (or pulp) to maintain a given brightness level over time.
clearcutting	The process of harvesting all trees on an area in one operation, rather than selectively.
consistency	Weight of dry fibre per weight of dry fibre plus water. (unit: per cent)
cull	The component of timber volume which is rejected, owing to decay or other defects, when trees are measured according to accepted scaling rules and standards
decay	Structural defect in wood, resulting from the intermediate and advanced stages of fungal attack, as recognized by a discernible loss in hardness.
economy of scale	Economically sized mill, approximately achieving the lowest average cost per unit of production in relation to discrete major items of capital equipment (e.g. a recovery boiler in a kraft mill).
fines (pulp)	Small fibre particles usually expressed as the percentage of pulp passing a 100 mesh screen.
fluff pulp	High bulk pulp used for diapers.
forest management unit (FMU)	An administrative area for which an annual allowable cut is calculated, as designated by the Alberta Forest Service.

freeness (CSF)	A measure of the rate at which water will drain through a pad of pulp. Commonly used to estimate drainage behaviour on a paper machine. It is particularly important for mechanical pulps and as such is considered a rough measure of pulp quality, being correlated to bulk, opacity, strength and shives. It is less important for chemical pulps. In terms of quality it should only be used between pulps produced by the same process. Typical values for chemical pulps are 400-650; up to 350 for mechanical pulps used for tissue and board; 100-150 for mechanical pulps used for newsprint; and 50-90 for mechanical pulps used for LWC grades.
greenfield	New mill including all facilities and costs.
growing stock	The stock of trees growing in a forest, usually measured in terms of volume.
hardwoods	Trees with broad leaves which are usually shed each year and with seeds which are formed inside a seed case; in this report the term is confined to aspen, balsam poplar and birch.
haul distance	The distance from where timber is harvested to where it is manufactured into forest products.
high yield pulp	Pulp with a yield over 85% based on dry weight of wood.
incipient decay	An early stage of decay where the cell walls making up the wood are beginning to breakdown.
integrated (paper mill)	Mill with the pulping facilities connected to paper mill.
mean annual increment (MAI)	The volume per hectare of timber in a stand divided by its age.
mixedwood	Forest containing a mixture of hardwood and softwood trees.
moisture content (wood)	Weight of water per weight of wood plus water. (unit: per cent).

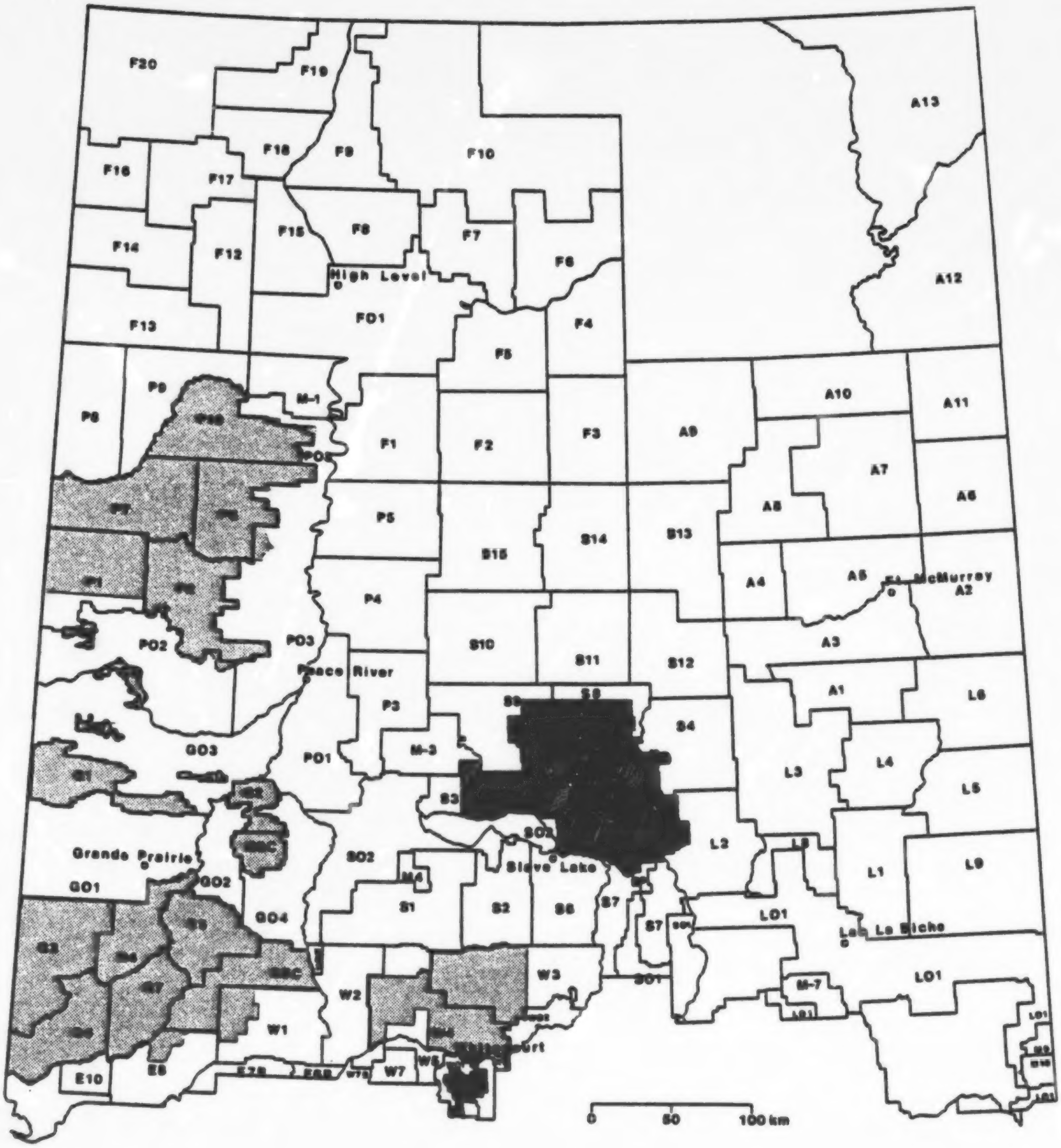
non-integrated (paper mill)	Pulp produced on a location separate from the paper mill.
quota	A share of a management unit's allowable cut, allocated to a particular operator.
rotation	The length of time required between successive forest harvests.
scaling	The process of measuring the volume or weight of trees or logs after they have been harvested.
secondary fibre	Recycled fibre (such as waste paper or carton clippings).
shives	Two or more fibres connected together. Usually expressed as the percentage of fibre retained on a .006 in. slotted screen.
silviculture	The science and art of growing and tending forests
single-line mill	A mechanical pulp mill with one main pulp flow. It could have a number of refiners, screens and so on.
softwoods	Trees with needle-like leaves, usually evergreen and with naked seeds formed on cones; examples are spruce and pine.
stain	Discolouration of wood, not necessarily accompanied by structural weakness.
stand	A uniform area of trees, the smallest area unit recognized in forest management.
thrifty	(As applied to forest stands) without waste resulting from disease.
two-line mill	A mechanical pulp mill with two separate pulp flows. Flows can be interconnected for fibre transfer.
wet strength	Tensile strength of a wet mat of fibres. (units: Newtons/m)
white water	Process water in a pulp or paper mill containing pulp fibre and fines.

wood-containing (paper)	Paper containing mechanical pulp, usually over 10 per cent.
wood-free (paper)	Paper containing less than 10 per cent mechanical pulp, usually 0 per cent.
yield (pulp)	Dry weight of fibre based upon dry weight of wood. (unit: per cent)

Abbreviations

admt/d (ADMTPD)	air dry metric tonne(s) per day
ADMTPA	air dry metric tonne(s) per annum
API	American Paper Institute
BCFP	British Columbia Forest Products Limited
Bleached CTMP/ BCTMP	bleached chemi-thermomechanical pulp
BDU	bone dry unit
BKP	bleached kraft pulp, 80-90 brightness
BOD	biochemical oxygen demand
CMP	chemi-mechanical pulp
CPPA	Canadian Pulp and Paper Association
CSF	Canadian Standard Freeness
CTMP	chemi-thermomechanical pulp
DBH	diameter breast height
DTA	deciduous timber allocation
FAO	Food and Agriculture Organization of the United Nations
FIRA	Foreign Investment Review Agency
FMA	forest management area agreement
g/cm^3	grams per cubic centimetre, units of density
G.E.	General Electric, units of brightness of paper
ha	hectares
Hwd	hardwood
ISO	International Standards Organization
km	kilometre
LVL	laminated veneer lumber

m3	cubic metre
MDF	medium density fibreboard
n/a	not available
N/A	not applicable
n.s.	not significant
NSSC	neutral sulfite semichemical
OSB	oriented strand board
PGW	pressurized groundwood
P/W	printing/writing (paper)
R & D	research and development
RMP	refiner mechanical pulp
SBK	semi-bleached kraft, approximately 65-75 brightness
SC	super calendered
SCA	Svenska Cellulose AB.
SCMP	sulfonated chemi-mechanical pulp, Canadian International Paper process
SGW	stone groundwood
S-P-F	spruce-pine-fir (balsam)
Swd	softwood
t	metric tonne
TMP	thermomechanical pulp
tpd	tonne per day
tpy	tonne per year
U/c	uncoated (paper)
UKP	unbleached kraft pulp

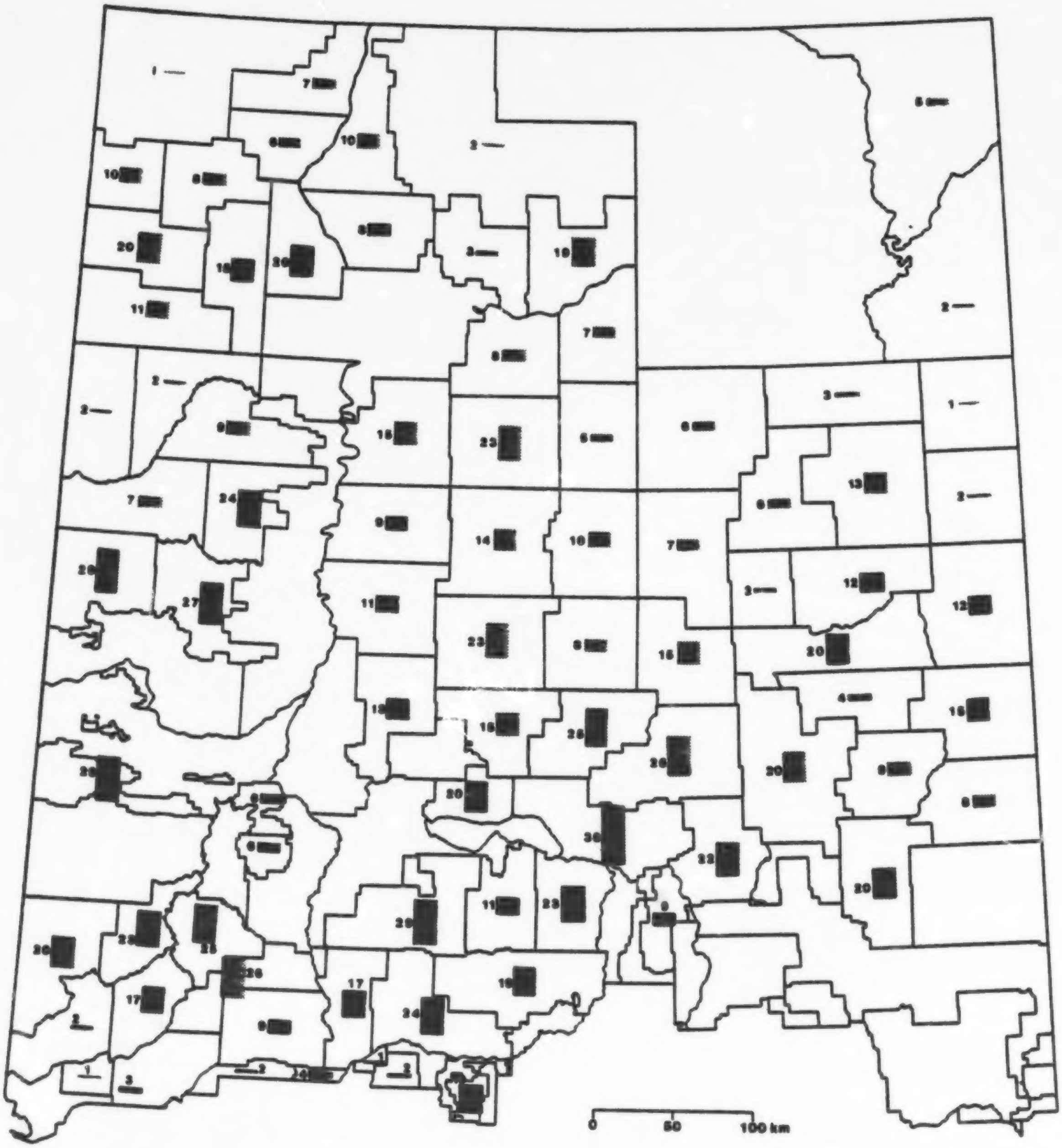

F20
F19
F18
F9
F10
A13
F16
F17
F14
F12
F15
F8
F7
F6
High Level
A12
F13
FD1
F4
F5
P8
P9
M-1
F1
F2
F3
A9
A10
A11
PO5
A7
A8
A6
P7
P5
S15
S14
S13
P1
A4
A5
McMurray
A2
P4
PO2
PO3
A3
S10
S11
S12
Peace River
P3
S9
S8
A1
L6
S4
M-3
GO3
PO1
L3
L4
G1
L5
S3
SO2
L2
Grande Prairie
SO2
L9
Slave Lake
GO1
GO2
M4
L1
S1
S2
S6
S7
S7
GO4
LO1
Lac La Biche
W3
W2
LO1
SO1
M-7
W1
LO1
E10
E8
W7
W6
Whitecourt
LO1
0
50
100 km

MAP 1

FOREST MANAGEMENT UNITS

■ Hardwood supply areas

▨ Forest management and reserve areas

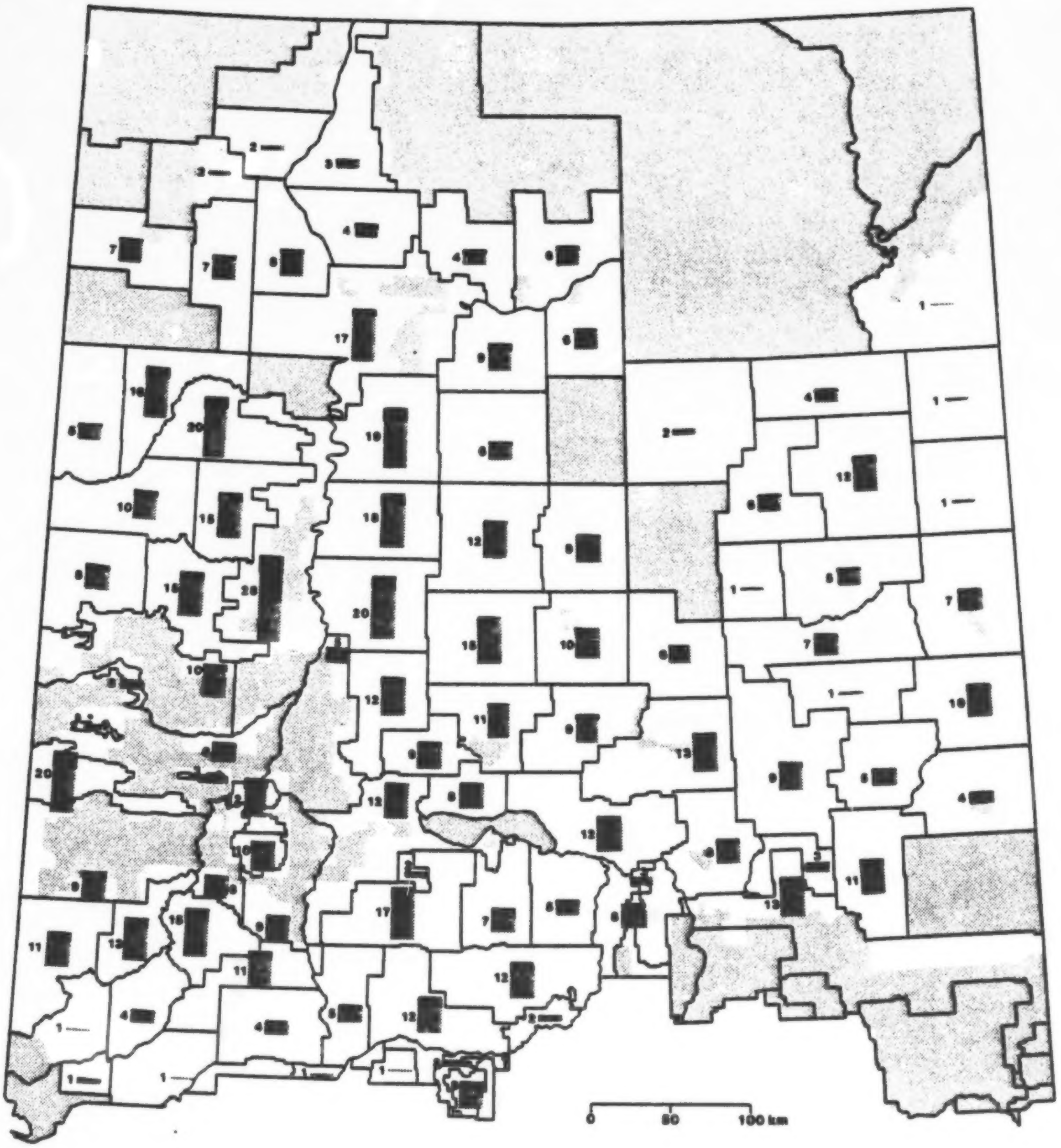


MAP 2

HARDWOOD ANNUAL ALLOWABLE CUTS

Unit AAC's stated in cubic metres x 10,000

■ Most accessible ■ Intermediate ■ Least accessible



MAP 3

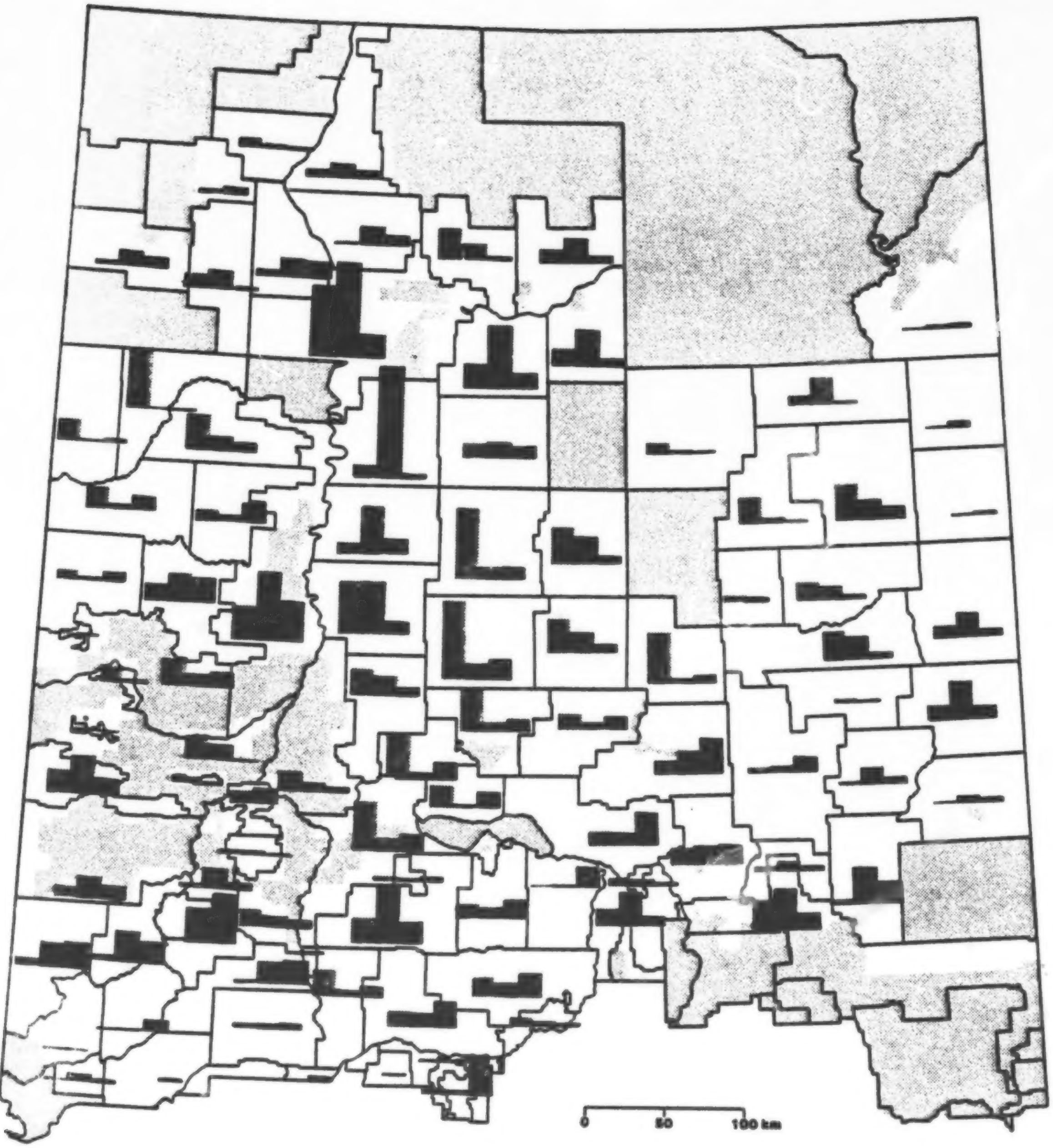
VOLUME AND SPECIES DISTRIBUTION

■ Trembling aspen ■ Balsam poplar ■ White birch

Net merchantable volume (all species, 15/10 utilization standard)

stated in millions of cubic metres

▨ non-inventoried areas



MAP 4
AREAS OF PURE HARDWOOD STANDS BY AGE CLASS

■ 0 - 45 years (sub-merchantable)

■ 50 - 75 years (merchantable, thrifty)

■ 80 years + (merchantable, decay-prone)

▬ 10,000 ha

◆ non-inventoried areas